The Knowledge, Perceptions and Practices of Healthcare Professionals Regarding Enteral Feeding of Premature and Low Birth Weight Infants in South Africa

by Margot Bradfield

Thesis presented in partial fulfilment of the requirements for the degree Master of Nutrition at the University of Stellenbosch

Supervisor: Supervisor: Dr E van Niekerk

Co-supervisor: Dr JCF du Preez

Statistician: Ms T Esterhuizen

Faculty of Medicine and Health Sciences

Department of Interdisciplinary Health Sciences

Division of Human Nutrition

March 2017

DECLARATION

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third-party rights and that I have not previously, in its entirety or in part, submitted it for obtaining any qualification.

Margot Bradfield

March 2017

ABSTRACT

Background

Nutrition in the premature infant is aimed at attaining similar growth and body composition to that of foetal growth and body composition. Postnatal growth will depend on the extrauterine environment, including the type, quality and quantity of feeds provided. Inadequate postnatal growth and nutrition has been linked to poor neurodevelopmental outcomes. Adequate nutrition and enteral feeding practices are necessary to prevent postnatal growth failure and poor cognitive outcomes in premature infants.

Aims and objectives

The study aimed to determine the knowledge, perceptions and practices of healthcare professionals regarding enteral feeding (including breastfeeding, formula feeding, breastmilk fortifier and donor breastmilk) of premature and low birth weight (LBW) infants in South Africa.

Participants and methods

A descriptive cross-sectional study with an analytical component was conducted from November 2015 until May 2016. The study took the form of an online survey using the web-based program, “Survey Monkey”. The study population comprised doctors and dietitians from the public and private sectors who are involved in the care of premature and low birth weight (LBW) infants. A total of 76 participants started the survey, of whom 30 (39%) completed fewer than five questions and were excluded from the data analysis. The final sample was composed of 46 participants.

Results

A significant difference ($p = 0.025$) between government and private sectors was observed for the initiation time of enteral feeds for very low birth weight (VLBW) infants. Most doctors and dietitians attempt to increase enteral feed volume daily for all birth weight categories. A significant difference was observed between doctors and dietitians ($p = 0.039$) with respect to the full enteral feeding volume, and a significant difference ($p = 0.036$) was noted between doctors and dietitians on whether nutrients are calculated in their facilities. Most doctors and dietitians chose an enteral target

energy of 100–135 kcal/kg/day for all the birth weight categories. A significant difference was found between the energy prescriptions between the government and private sector for each birth weight category [$< 1\,000$ g ($p = 0.038$), $< 1\,500$ g ($p = 0.027$), $< 2\,000$ g ($p = 0.019$), $< 2\,500$ g ($p = 0.045$)]. Beliefs and perceptions were in line with current evidence and recommendations, and reflect the practices of healthcare professionals.

Conclusion

In this study, differences existed between certain practices between healthcare professionals as well as between hospital sectors. A significant difference was not found in the total knowledge scores between healthcare professionals and the international feeding recommendations.

OPSOMMING

Agtergrond

Voeding van die premature baba is gemik daarop om soortgelyke groei en liggaamsamestelling te behaal as die van fetale groei en liggaamsamestelling. Post-natale groei sal afhang van die ekstra-uteriene omgewing, insluitend die tipe, kwaliteit en kwantiteit van voedings wat verskaf word. Onvoldoende post-natale groei en voeding is gekoppel aan swak neuro-ontwikkeling uitkomste. Voldoende voeding en enterale voedingpraktyke word benodig om gebrekkige post-natale groei en swak kognitiewe uitkomste in premature babas te voorkom.

Doelstellings en doelwitte

Die doel van hierdie studie was om die kennis, persepsies en praktyke vas te stel van professionele verskaffers van gesondheidsorg aangaande enterale voeding (insluitend borsvoeding, formule voeding, borsmelk verrykers en skenker borsmelk) van premature en lae geboorte massa (LGM) babas in Suid Afrika.

Deelnemers en Metodes

‘n Beskrywende deursnit studie met ‘n analitiese komponent is vanaf November 2015 tot Mei 2016 uitgevoer. Die studie is uitgevoer in die formaat van ‘n aanlynopname met gebruik “Survey Monkey”. Die studie populasie het bestaan uit dokters en dieetkundiges vanuit die openbare en die privaat sektors wat betrokke is met die versorging van premature en LGM babas. In totaal het 76 deelnemers het die opname begin, waarvan 30 (39%) minder as vyf vrae van die opname voltooi het. Hierdie deelnemers is uitgesluit uit die data analise. Die finale populasie het bestaan uit 46 deelnemers.

Resultate

‘n Beduidende verskil is waargeneem in die aanvangstyd van enterale voeding vir baie lae geboorte massa (BLGM) babas tussen openbare- en privaat sektors ($p = 0.025$). Die meerderheid dokters en dieetkundiges poog om enterale voeding se volume op ‘n daaglikse basis te verhoog vir alle geboorte gewig kategorieë. ‘n Beduidende verskil is waargeneem tussen dokters en dieetkundiges ($p = 0.039$) met betrekking tot die volle enterale voedings volume en ‘n beduidende verskil is waargeneem ($p = 0.036$)

tussen dokters en dieetkundiges rakende die berekening van nutriente in hulle fasiliteite. Die meerderheid dokters en dieetkundiges het ‘n enterale teiken energie van 100–135 kcal/kg/dag vir al die geboortegewig kategorieë verkies. ‘n Beduidende verskil is gevind tussen die energie voorskrifte van die openbare en privaatsektore vir elke geboortegewig kategorie ($< 1\,000$ g ($p = 0.038$), $< 1\,500$ g ($p = 0.027$), $< 2\,000$ g ($p = 0.019$), $< 2\,500$ g ($p = 0.045$). Oortuigings en waarnemings was in lyn met huidige gegewens en aanbevelings en weerspieël die praktyke van die gesondheidsorg verskaffers.

Gevolgtrekking

In hierdie studie het verskille bestaan tussen sekere praktyke en gesondheidsorg verskaffers so wel as tussen hospitaal sektore. ‘n Beduidende verskil was nie waargeneem tussen die totale kennis tellings tussen die gesondheidsorg verskaffers en die internasionale voedings aanbevelings nie.

ACKNOWLEDGMENTS

I would like to extend my sincere gratitude to:
My supervisors, Dr Evette van Niekerk and Dr du Preez, for their valuable time, expertise, mentorship and support throughout the duration of the research process.

The Division of Human Nutrition for its support and guidance.

Mrs Claudia Schübl from the Department of Human Nutrition, Tygerberg Academic Hospital and Professor Gert Kirsten for their valuable time and input into the study questionnaire.

My colleagues Dr N Gwavu and Dr B Ngubeni for their appreciated time and support during the study.

Dr Tanusha Ramdin and Dr Asma Salloo for their encouragement during the study.

Tonya Esterhuizen, my assigned statistician from the Department of Biostatistics, for her input, knowledge and time.

My partner, Xander de Bruyn for his interest, understanding, love and motivation throughout the study. My wonderful family for their motivation, love and support throughout the study.

CONTRIBUTIONS

Margot Bradfield (principal researcher) developed the research idea and protocol. Margot Bradfield, with the support of Dr Evette van Niekerk (supervisor) and Dr Miemie du Preez, (co-supervisor) designed the research study. Margot Bradfield performed the data collection and captured the data. The data was analysed with the assistance of Tonya Esterhuizen (statistician) and was interpreted by Margot Bradfield. Margot Bradfield drafted the dissertation and Dr Evette van Niekerk and Dr Miemie du Preez reviewed the data and the dissertation. Dr Evette van Niekerk critically reviewed the paper. All authors read and approved the final versions of the dissertation.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Article

LIST OF APPENDICES

LIST OF ABBREVIATIONS

AA: Arachidonic acid

ADSA: Association for Dietetics in South Africa

AGA: Appropriate for gestational age

AAP: American Academy of Pediatrics

ART: Antiretroviral therapy

ARV: Antiretroviral

BMI: Body mass index

BPD: Bronchopulmonary dysplasia

BUN: Blood urea nitrogen

DHA: Docosahexaenoic acid

ELBW: Extremely low birth weight

ESPGHAN: European Society for Paediatric Gastroenterology, Hepatology and Nutrition

EUGR: Extrauterine growth restriction

HIV: Human immunodeficiency virus

HREC: Health Research Ethics Committee

IgA: Immunoglobulin A

IUGR: Intrauterine growth restriction

KMC: Kangaroo Mother Care

LBW: Low birth weight

NEC: Necrotising enterocolitis

SABR: South African Breastmilk Reserve

SAPA: South African Paediatric Association

SGA: Small for gestational age

UNICEF: United Nations Children's Fund

VLBW: Very low birth weight

WHO: World Health Organization

CHAPTER 1

LITERATURE REVIEW

CHAPTER 1: INTRODUCTION & LITERATURE REVIEW

1.1 INTRODUCTION

Annually, about 15 million infants are born prematurely, and prematurity is the leading cause of death in children under five years of age. Every year, about 1.1 million infants die of complications from premature birth. Prematurity not only increases the risk of mortality but also the risk of disability and long-term effects such as visual and hearing impairment and mild to severe neurodevelopmental and behavioural problems. Advances in medicine and research have significantly increased survival rates among premature infants, particularly in developed countries. As countries progress, survival rates of premature infants should also improve, which may increase morbidity associated with prematurity.[1–3]

More than 60% of premature births occur in Africa and South East Asia. About 9% of infants are born premature in higher income countries, compared with 12% in lower income countries.[1,4]

A premature infant can be defined as an infant born alive before 37 weeks' gestation.[5,6] Premature infants are further sub-categorised based on their weight or gestational age. Infants weighing less than 2 500 g are considered low birth weight (LBW), infants weighing less than 1 500 g are very low birth weight (VLBW) and infants weighing less than 1 000 g are extremely low birth weight (ELBW).[6] The World Health Organization (WHO) classifies infants based on their gestational age as follows: infants from 32 weeks until younger than 37 weeks are moderate to late premature, 28 weeks until younger than 32 weeks are very premature, and younger than 28 weeks are extremely premature.[2]

Infants can also be defined based on their birth weight compared with the standard weight for the infant's gestational age. Appropriate for gestational age (AGA) can be used to describe an infant whose birth weight is between the 10th and 90th percentile for their gestational age. A small for gestational age (SGA) infant can be defined as having a birth weight of below the 10th percentile of the standard weight for gestational age. A large for gestational age (LGA) infant has a birth weight above the

90th percentile of the standard weight for age. The updated *Babson and Benda,* also known as the *Fenton fetal-infant growth charts,* can be used for monitoring growth of premature infants from 22 weeks gestational age until 10 weeks post-term age.[7] A foetus with a decreased growth rate can be said to have intrauterine growth restriction (IUGR), which is classified in two ways: asymmetrical and symmetrical IUGR. Asymmetrical IUGR can be defined as an SGA infant whose intrauterine weight gain is poor but whose linear and head growth is between the 10th and the 90th percentile (head and linear growth is spared) and this indicates pathology later in pregnancy. Symmetrical IUGR can be defined as an SGA infant whose linear and head growth is also below the 10th percentile (weight, length and head circumference are below the 10th percentile) which indicates an abnormal process present during early pregnancy. SGA and IUGR infants are at an increased risk of poor growth postnatally.[6,8]

The aetiology and risk factors for premature delivery are vast and often multifactorial. Identified risk factors of premature birth include previous premature birth, multiple pregnancies, young or advanced maternal age, maternal nutritional factors such as micronutrient deficiencies and a low or high maternal body mass index (BMI), chronic conditions such as diabetes and hypertension, as well as lifestyle factors such as smoking, drug and alcohol consumption.[2,3]

In a South African cohort study, maternal HIV infection was associated with an increased risk of low birth weight infants.[9] The use of certain antiretroviral regimens has also been associated with an increased risk of premature delivery.[10,11] In 2013, the national HIV prevalence among pregnant women was 29.7%.[12] This high prevalence indicates that awareness of the risk of premature birth and caring for premature infants is imperative in South Africa.

1.2 NUTRITION AND GROWTH OF THE PREMATURE/LOW BIRTH WEIGHT INFANT

Nutrition in the premature infant is aimed at attaining similar growth and body composition to that of foetal growth and body composition.[13,14] Postnatal growth will depend on the extrauterine environment, including the type, quality and quantity of feeds provided.[14] Inadequate postnatal growth has been linked to poor

neurodevelopmental outcomes.[15–18] On the other hand, postnatal growth in premature infants that is more rapid than the expected foetal growth may contribute to problems in later life such as the risk of chronic diseases, for example diabetes.[19,20] Extrauterine growth restriction (EUGR) or postnatal growth failure is prevalent in AGA and SGA infants.[21, 22] EUGR can be defined as growth that is less than that of the estimated intrauterine growth of a foetus of the same age. A premature infant with a growth rate lower than the 10th percentile, when compared with a foetus of the same gestational age, has postnatal growth failure or EUGR.[21,23,24] A population-based study done in Israel demonstrated declines in postnatal growth failure from 1995-2010. These declines may be due to changes in the management of premature infants such as improved nutritional management.[24] Avoiding accrued nutrient deficits and growth failure will prevent negative long-term consequences.[22]

Establishing and sustaining enteral nutrition in premature infants becomes a challenge due to poor tolerance and an increased risk of necrotising enterocolitis (NEC), as a result of immature organs and an immature gastro-intestinal tract. Parenteral nutrition is often the main source of nutrition in premature and VLBW infants until enteral nutrition can be fully established. Enteral nutrition in premature infants is usually started with trophic feeds, which include the administration of minimal amounts of enteral nutrition, for example, one millilitre at a time. Enteral nutrition is more physiological than parenteral nutritional and, therefore, is the preferred mode of nutrition. These minimal feeds contribute to stimulating the development of an infant's immature gastro-intestinal tract, including lactase activity.[6,14,25–27] Once trophic feeds are tolerated, they need to be increased to meet the infant's full requirements. The infant needs to be weaned off parenteral nutrition while enteral nutrition is increased so as to avoid any fluid or nutrient deficits.

1.2.1 Initiation of enteral nutrition

The results of the 2013 Cochrane review indicate, from nine small trials, that early trophic feeding compared with fasting did not significantly bring about an improvement in bowel maturation, nor did it increase the risk of NEC and nosocomial sepsis. However, the author concluded that these findings were limited and that more evidence is required.[28]

Studies have indicated that there is no advantage to delaying the initiation of enteral feeds for more than 24 to 48 hours after birth. The early introduction of enteral feeds has been shown to reduce the number of days of parenteral nutrition and to reduce cholestatic jaundice. Full enteral feeds are established earlier when enteral feeds are initiated earlier[6,29,30] and an infant's weight gain has also been shown to be better with the earlier initiation of enteral feeds.[30] A 2015 study showed that delaying the initiation of enteral feeds by 72 hours may be associated with an increase in intestinal inflammation and greater morbidity.[31]

A South African study conducted in 2013 evaluating feeding practices of paediatricians indicated that 65% of infants with a gestational age between 28 and 31 weeks receive enteral feeds within the first 24 hours of birth.[32]

1.2.2 Enteral nutrition requirements

A 2007 study by Ziegler reviewed the energy and protein requirements of very low birth weight infants. The study reviewed nutritional requirements estimated by means of the empirical method compared with the factorial method. The factorial approach determines the nutrient requirements by means of adding the requirements for energy and protein necessary for growth to those of unavoidable losses. The empirical method estimates the nutritional requirements by manipulating the intake of protein and energy and determining the relationship between the intake of energy and protein, and growth. Table 1.1 depicts the estimated weight gain and the energy and protein requirements based on the factorial approach.[27,33]

The committee on nutrition for the European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) reviewed the recommendations for macro- and micronutrient intake for premature infants and created a guideline for specific nutrient intakes for premature infants.[13] The American Academy of Paediatrics (AAP) also published consensus guidelines for the recommended nutrient intakes for premature infants.[14] The ESPGHAN feeding guidelines are aimed at infants weighing 1 000 g to 1 800 g while the AAP guidelines focus on nutrient intakes for infants weighing 1 000 g to 1 500 g.

Table 1.2 presents a summary of these guidelines for infants weighing less than 1 000 g and up to 1 800 g.[13,14]

Nutrition in the later premature and LBW infant also needs to be considered. These infants are often stable and may be discharged soon after delivery, but gaps may be found in their nutritional care. These infants also have higher nutritional requirements for energy, protein and calcium in comparison with term infants.[34]

Table 1.1: **Enteral nutrition protein and energy requirements as determined by the factorial approach**

Range of body weight (g)		500–700	700–900	900–1 200	1 200–1 500	1 500–1 800	1 800–2 200
Weight gain	**g/day**	13	16	20	24	26	29
	(g/kg/day)	21	20	19	18	16	14
Protein (g)	**Inevitable loss**	1	1	1	1	1	1
	Growth	2.5	2.5	2.5	2.4	2.2	2
	Required enteral intake	4	4	4	3.9	3.6	3.4
Energy (kcal)	**Loss**	60	60	65	70	70	70
	REE	45	45	50	50	50	50
	Miscellaneous	15	15	15	20	20	20
	Growth	29	32	36	38	39	41
	Required enteral intake	105	108	119	127	128	131
Protein / energy (g/100kcal)	**Enteral**	3.8	3.7	3.4	3.1	2.8	2.6

Adapted from Ziegler et al.[27,33]

1.2.3 Enteral nutrition recommendations

1.2.3.1 Energy

The energy requirements of premature infants are considered to be similar to those of the foetus in the intrauterine environment. Variations between the intrauterine and extrauterine environment do, however, need to be taken into consideration to maintain a similar growth pattern and body composition.[13]

The gestational age, resting energy expenditure, accrued nutrient deficits and differences in body composition are all contributors to the energy requirements of these infants. More energy per kilogram of body weight is required for an infant born at a younger gestational age. In the first week of life, the resting energy expenditure tends to be lower for premature infants compared with the weeks that follow.[14]

Less energy is required for infants who are fed parenterally than enterally-fed infants, where nutrients are lost due to absorption. For parenterally fed infants, resting energy requirements are approximately 40 kcal/kg/day compared with enterally fed infants who require about 50 kcal/kg/day by the second and third weeks of life (Table 1.1). Once the energy required for metabolic processes, energy losses and growth has been taken into account, 105–130 kcal/kg/day is required.[6,13,14,33] In some cases, such as in bronchopulmonary dysplasia, up to 150 kcal/kg/day may be required.[6]

The energy requirements for larger but later premature infants with a gestational age of between 32 and 39 weeks are 115–130 kcal/kg/day.[34]

1.2.3.2 Protein

Once the protein required for growth, accrued deficits and obligatory losses has been accounted for, the protein required to sustain growth in premature infants is between 3.5 and 4.5 g/kg/day (Table 1.1). Infants born earlier tend to have higher protein requirements (g/kg/day) than older infants. The amino acid composition and the quality of the proteins provided are also important factors to consider for premature infants.[6,13,14,33]

The protein requirements for larger premature infants with a gestational age of about 32 to 39 weeks are 2.5–3.5 g/kg/day.[34]

1.2.3.3 Carbohydrates

Carbohydrates are an important source of accessible energy for premature infants, and should contribute 40–50% of the total energy requirements, or about 10–14 g/kg/day. Insufficient carbohydrate intake may result in hypoglycaemia, while an excessive carbohydrate intake may lead to hyperglycaemia or result in diuresis and loose stools.[6,13,14]

1.2.3.4 Fat

Fat is a large source of energy for premature infants and 40–50% of total energy should be derived from fat. Dietary fat also contributes essential polyunsaturated fatty acids and fat-soluble vitamins. The quantity and the type of dietary fats affect the growth and body composition of the premature infant. Polyunsaturated fatty acids are abundant in the brain and the retina.[6,13,14]

Essential fatty acid intake in premature infants is important and is estimated at 3% of total energy requirements. It is derived from linoleic acid and lesser amounts of α-linolenic acid. Arachidonic acid (ARA) and docosahexaenoic acid (DHA) are derived from α-linolenic acid and are important for visual and cognitive development.[6,13,14]

1.2.3.5 Minerals, trace elements and vitamins

Table 1.2 provides a summary of the recommended enteral intakes of minerals, trace elements and vitamins. The majority of minerals and vitamins are accumulated by the infant during the third trimester, which results in premature infants generally having low body stores of many of these micronutrients. Term infants and premature infants require the same vitamins and minerals; however, due to reduced body stores, illness and elevated requirements for growth, premature infants require more than term infants.[6,13,14]

Premature infants are at a risk of developing osteopenia of prematurity due to poor mineral stores at the time of birth and a poor dietary intake during the first weeks of life. The calcium to phosphorous ratio is a significant factor in ensuring calcium absorption and retention. Adequate vitamin D intake is also essential to prevent osteopenia of prematurity.[6,13,14]

A higher urinary excretion of sodium is displayed in premature infants compared with term infants and therefore more sodium is required to prevent hyponatremia. Potassium requirements, however, are similar to those of term infants.[6,14]

Due to low iron stores and frequent blood drawing, premature infants are at risk of iron deficiency. Iron deficiency is usually treated in the first few weeks of life by blood transfusions and not by iron therapy. Because iron is vital for brain development, it is important to avoid iron deficiency in these already vulnerable infants. Iron overload also needs to be avoided as it has been linked to increasing the risk of retinopathy of prematurity. Iron-fortified preterm formulas or human milk fortifier usually provide sufficient quantities of iron.[6,13,14] Infants receiving unfortified human milk should receive an iron supplement such as ferrous sulphate drops.[6] Iron supplementation should continue until 6–12 months of age.[13]

The recommended intake of fat and water-soluble vitamins are summarised in Table 1.2. Preterm infant formula or fortified human milk usually provides adequate amounts of these nutrients to meet the recommended intakes.[13,14]

1.2.3.6 Probiotics and prebiotics

Studies have indicated that probiotic administration may result in reduced instances of NEC. However, insufficient evidence is available to routinely recommend the use of probiotics in premature and LBW infants.[13,35,36]

Table 1.2: **Comparison of enteral nutrition recommendations for premature infants**

Nutrient	ESPGHAN recommendations		AAP consensus recommendations	
	< 1000 g	(1000–1800 g)	< 1 000 g	(1 000–1 500 g)
	Per kg / day			
Fluid, ml		135–200		
Energy, kcal		110–135	130–150	110–130
Protein, g	4–4.5	3.5–4	3.8–4.4	3.4–4.2
Carbohydrates, g		11.6–13.2	9–20	7–17
Fat, g		4.8–6.6	6.2–8.4	5.3–7.2
Linoleic acid, mg		385–1 540	700–1 680	600–1 440
α-linoleic acid, mg		> 55 (0.9% fatty acids)		
DHA, mg		12–30	≥ 21	≥ 18
AA, mg		18–42	≥ 28	≥ 24
Vitamin A, IU		1 332–3 330	700–1 500	700–1 500
Vitamin D IU/day		800–1 000	150–400	150–400
Vitamin E, mg		2.2–11	6–12	6–12
Vitamin K_1, µg		4.4–28	8–10	8–10
Ascorbate, mg		11–46	18–24	18–24
Thiamine, µg		140–300	180–240	180–240
Riboflavin, µg		200–400	250–360	250–360
Pyridoxine, µg		45–300	150–210	150–210
Niacin, µg		380–5 500	3.6–4.8	3.6–4.8
Pantothenate, mg		0.33–2.1	1.2–1.7	1.2–1.7
Biotin, µg		1.7–16.5	3.6–6	3.6–6
Folate, µg		35–100	25–50	25–50
Vitamin B12, µg		0.1–0.77	0.8	0.3
Sodium, mg		69–115	69–115	69–115
Potassium, mg		66–132	78–117	78–117
Chloride, mg		105–177	107–249	107–249
Calcium, mg		120–140	100–220	77–200
Phosphorous, mg		60–90	60–140	60–140
Magnesium, mg		8–15	7.9–15	7.9–15
Iron, mg		2–3	2–4	2–4
Zinc, mg		1.1–2	1 000–3 000	1 000–3 000
Copper, µg		100-132	120-150	120-150
Selenium, µg		5–10	1.3–4.5	1.3–4.5
Chromium, ng		30–1 230	0.1–2.25	0.1–2.25
Manganese, µg		≤ 27.5	0.7–7.75	0.7–7.75
Molybdenum, µg		0.3-5	0.3	0.3
Iodine, µg		11–55	10–60	10–60
Taurine, mg			4.5–9	4.5–9
Carnitine, mg			≈ 2.9	≈ 2.9
Inositol, mg		4.4–53	32–81	32–81
Choline, mg		8–55	14.4–28	14.4–28

Adapted from Agostoni et al[13] and the American Academy of Pediatrics[14]

1.2.4 Enteral feeding type

1.2.4.1 Human milk

Breastmilk, the mother's own milk, is the feed of choice for premature infants. Not only does breastmilk provide macronutrients and micronutrients, but it also contains immune factors, such as immunoglobulin A (IgA), oligosaccharides, leukocytes, lysozymes, cytokines, nucleotides, interferon-ɣ as well as essential fatty acids, hormones, enzymes and other biologically active compounds. These components provide immunological and antimicrobial protection for the infant. Lactose is the most prevalent disaccharide in human milk. Due to the immaturity of the premature infant's gastrointestinal tract, the lactase activity is low; however, in the clinical setting, lactose intolerance is not usually a matter of concern.[6,13,14,27,37]

Human milk is rich in oligosaccharides, carbohydrate materials that act as prebiotics and promote the growth of healthy bacteria. A portion of these oligosaccharides are absorbed in the small intestine, while the majority enter the colon where they promote the growth of probiotic flora. The oligosaccharides may also play an important part in the prevention of NEC as they block the attachment of potentially pathogenic bacteria to the mucosa.[13,14,38]

Because the composition of breastmilk changes throughout a feed and throughout the duration of lactation, it is not a constant fluid. Colostrum, foremilk and hind milk all differ in their composition.[6,13,14,39] Studies have also shown that the composition of breastmilk differs between mothers who gave birth to premature infants and mothers who gave birth to term infants. Breastmilk from mothers who had preterm delivery tends to have more energy, protein, fat and sodium compared with term milk.[14,40] The quantities of lactose, calcium and phosphorous tend to be a bit lower in preterm milk.[14]

Premature infants tolerate human milk better than infant formula and full enteral feeding is established sooner when human milk is used. The use of human milk has shown a lower incidence of sepsis and NEC when compared with the use of formulas in premature infants and, therefore, a reduction in infant morbidity and mortality.[14,41] The use of human milk may also reduce the severity of retinopathy of prematurity,[42] and bronchopulmonary dysplasia, and may improve cognitive outcomes.[43,44]

The 2016 WHO guidelines on HIV and infant feeding indicate that if a mother who is living

with HIV is receiving ARVs and her adherence to ARVs is fully supported, and if she is not virally suppressed, she may continue to breastfeed for up to 24 months.[45]

The experience of providing a mother's own milk to her infant may be beneficial for the mother as it encourages interaction and participation in the treatment and management of her infant. However, human milk becomes nutritionally inadequate to meet the extreme needs of the premature infant and needs to be fortified.[14,26]

1.2.4.2 Infant formula

Term infant formula does not meet the macronutrient and micronutrient requirements of premature infants. Preterm infant formulas have been designed to meet their nutritional requirements, but do not contain the non-nutritive components present in human milk. These non-nutritive components provide antimicrobial and immunological benefits, whereas infant formula poses the risk of an increase in inflammatory factors, sepsis and NEC.[6,14,38]

Powdered infant formula is not sterile and may even contain pathogenic bacteria. *Cranobacter spp.,* formerly known as *Enterobacter sakazakii* has been found to be present in powdered infant formula and has been linked to causing infections in infants and morbidity such as meningitis, septicaemia, bacteraemia and NEC.[46–48]

Ready-to-use (RTU) sterile liquid infant formulas are available but are not without risks. Milk and milk products are a good source of nutrition for bacteria and if not prepared or handled correctly, may promote the spread of pathogenic bacteria. During the preparation and handling phase, these products may become contaminated, thus posing a threat to these vulnerable infants. The heating processes used to sterilise these formulas may also destroy essential nutrients.[46] Because RTU formulas are costly to procure, they may not be accessible, particularly in South African government-funded facilities.

1.2.4.3 Donor breastmilk

Mothers of premature infants may not produce sufficient breastmilk post-delivery or may even be too ill to lactate when enteral feeds need to be initiated. The American Academy of Pediatrics (AAP) recommends that if the mother's own milk is not available, fortified, pasteurised donor human milk should be used for premature infants.[37] Studies have indicated that donor milk is more protective against NEC than infant formula.[49]

The use of donor milk when mother's own milk is not available has increased, but there are still challenges and concerns amongst recipients regarding its use. A South African study indicated that there are challenges around the acceptability of using donor breastmilk and more education is needed to improve understanding of the role of donor breastmilk.[50] Coutsoudis et al. showed in a 2011 study that it is safe and feasible to set up a breastmilk bank in South Africa.[51]

In the South African context, many government-funded tertiary hospitals have onsite breastmilk banks or access to donor breastmilk. The South African Breastmilk Reserve (SABR) is a non-profit organisation that assists in supplying donated breastmilk to hospitals in need of donor milk for premature infants. Donor milk is currently supplied to government hospitals free of charge and to private facilities for a small fee. However, from October 2016 all facilities will be required to pay a small fee to receive donor breastmilk from SABR in order to fund the running costs of pasteurising and bottling the donor milk. SABR has 44 breastmilk banks which assist in supplying donor milk to about 100 facilities.[52] There is also the iThemba Lethu Breastmilk Bank in KwaZulu-Natal and the Milk Matters Breastmilk Bank in the Western Cape.[52–54]

The SABR provides donor breastmilk to infants who have a high risk of developing NEC. The following criteria are used for infants to receive donor milk: i) birth weight of less than 1 800 g; ii) less than 14 days old; iii) maternal contraindications to breastfeeding, or mother critically ill, or maternal death; and iv) infants who are abandoned.

Donor milk is often sourced from mothers of term infants who have an abundant supply of breastmilk and it undergoes a pasteurisation process before it can be used. Different methods of pasteurisation, a process involving heat-treating milk, are used. One method, flash heating, entails heating the milk to a high temperature (about 72°C) very quickly. The holder pasteurisation method involves heating milk to a temperature of 62.5°C for thirty minutes using a commercial grade pasteuriser. Pasteurisation destroys potential pathogens while maintaining most of the nutritional and immunological factors associated with human milk.[26]

As with mother's own milk and due to the fact that donor milk is mainly sourced from the mothers of term infants, fortification is necessary to meet the preterm infant's nutritional requirements.

1.2.4.4 Human milk fortifier

The nutritional value of breastmilk alone is not sufficient to meet the high growth demands of the premature infant and needs to be fortified.[14,38,55] A Cochrane review on multi-nutrient fortification for preterm infants concluded that human milk fortifier results in temporary weight gain, and linear and head growth, but the long-term effects need to be studied.[56,57]

Human milk can be fortified by adding standard amounts of either a single nutrient modular product such as a protein supplement that is individualised to the infant's requirements, or a standard fortifier designed specifically for premature and LBW infants.[27,58] Standard fortification may not meet the infant's high protein requirements when compared with individualised fortification, which may be more accurate as it is tailored to the specific infant's requirements. However, the challenge with individualised fortification is that it comprises small amounts of modular products that would need to be measured out, which is more laborious and increases the osmolarity of the human milk.[55,58,59]

Two methods proposed for enhancing individualised fortification are adjustable and targeted fortification. Targeted fortification entails analysing the human milk and then fortifying it based on its nutrient analysis. Adjustable fortification involves measuring the infant's blood urea nitrogen (BUN) as this reveals the protein content of the diet, and then adjusting the protein according to these measurements.[58]

Internationally, liquid and powdered human formulas are available. In South Africa currently only one type of human milk fortifier is available, which is in a powder form and contains extensively hydrolysed cow's milk protein.[59] Fortification is usually started when the infant is receiving and tolerating 100 ml/kg/day or more of human milk.[58,59] The study by Kemp et al indicates that for a 1 000 g infant, when the human milk fortifier available in South Africa is used with human milk at the recommended dosage of one gram in 20 ml of human milk, the energy requirements based on ESPGHAN and AAP recommendations will only be met when the infant is receiving 150 ml/kg/day, and that when volumes higher than this are given, the energy provided will exceed recommendations. The protein requirements will only be met once 180 ml/kg/day is received, but then the energy requirements will be exceeded.[13,14,59]

1.2.4.5 Mixed feeding

WHO defines mixed feeding as the practice of giving an infant younger than six months of age other liquids or foods together with breastmilk.[45]

HIV can be transmitted through breastfeeding postpartum. A positive HIV diagnosis six weeks postpartum may be associated with HIV transmission through breastmilk.[60] Mixed feeding an HIV-exposed infant during the first month of life has been associated with an increased risk of postnatal HIV transmission.[61] Mixed feeding during the first six months of life in an HIV-exposed infant should be avoided and exclusive breastfeeding is recommended. However, the 2016 WHO guiding practice statements on HIV and infant feeding indicate that practising mixed feeding should not be a reason for a mother to stop breastfeeding if ARVs are being used, and that ART use reduces the risk of postnatal HIV transmission in the context of mixed feeding.[45]

In the South African context there is a high prevalence of HIV amongst pregnant women[12] as well as high numbers of mixed feeding amongst mothers.[62] The South African National Consolidated Guidelines for The Prevention of Mother-To-Child-Transmission of HIV (PMCT) and the Management of HIV in Children, Adolescents and Adults recommends that all HIV-positive, HIV-negative and women with and unknown HIV status should receive at least four antenatal counselling sessions and should be advised to exclusively breastfeed during the first six months of life with appropriate complementary foods being introduced at six months. HIV-negative women may continue to breastfeed until 2 years and HIV-positive women may continue to breastfeed until 12 months. Mothers must be counselled on the risks of mixed feeding as exclusive breastfeeding reduces the risk of HIV transmission.[63]

1.2.4.6 Kangaroo mother care

Kangaroo Mother Care (KMC) is the practice of placing premature infants in skin-to-skin contact with the mother to encourage their health and wellbeing by: i) providing warmth and sustaining correct temperatures; ii) safeguarding against infection; iii) providing nutrition through breastfeeding; iv) providing stimulation; and v) ensuring safety.[64] KMC has also been shown to have positive effects on the mother.[64]

The WHO recommends that new-born infants weighing less than 2 000 g should receive as close to continuous KMC as possible, or intermittent KMC if continuous KMC is not feasible.[65] A Cochrane review showed that that both intermittent and continuous KMC provides positive benefits for stabilised premature infants, and can be used as an alternative to conventional neonatal care (the use of incubators or radiant warmers) in resource-limited countries. The benefits provided by KMC include reduced morbidity, mortality, hypothermia and length of hospital stay, improved weight gain and exclusive breastfeeding.[66]

In the Tshwane district of the Gauteng Province of South Africa, the implementation of district clinical specialist teams has proved to be beneficial for neonatal care at district-level hospitals, by communicating policies and assisting with the implementation of KMC at facilities in the region. These teams assist in training staff and provide onsite visits and support to enhance and improve the implementation of KMC at a district level and reduce the high burden of neonatal care on tertiary facilities.[67]

1.3 INFANT FEEDING POLICIES AND PROTOCOLS

Policies exist that protect, promote and support breastfeeding. Human milk is the enteral feed of choice for premature infants.[6,13,14] The Baby Friendly Hospital Initiative (BFHI) was started by WHO and United Nations Children's Fund (UNICEF) in 1991 in response to the Inoccenti Declaration. The BFHI includes Ten Steps to Successful Breastfeeding. It has been demonstrated that by adopting these policies improved rates of breastfeeding initiation, duration and exclusivity have been demonstrated.[37,68] In the public sector in South Africa the WHO/UNICEF BFHI Ten Steps to Successful Breastfeeding have been adopted and amended in order to improve rates of breastfeeding and address the needs of the mother as well as HIV and infant feeding.

NEC is the most common gastrointestinal emergency and a considerable cause of morbidity and death in premature infants. As a result of the unclear aetiology and pathophysiology of NEC strategies to prevent it are not well identified. Enteral feeding as well as prematurity are identified factors associated with NEC. A systematic review conducted by Patole indicates that the implementation of standardised infant feeding regimens or protocols may decrease or eradicate NEC in neonatal units. However, randomised controlled trials are still required to demonstrate this and to exclude other factors that may be associated with NEC.[69,70,71]

By adopting and amending policies and protocols on infant feeding it may help to improve the nutritional management and care and reduce the risk of morbidity and mortality in premature and LBW infants

1.4 RESEARCH QUESTION

What are the knowledge, perceptions and practices of healthcare professionals regarding

enteral feeding of premature and LBW infants in South Africa?

1.5 MOTIVATION FOR THE STUDY

Studies from as early as 1963, using animal models, have indicated that poor nutrition during the early stages of life reduces growth including the growth of the brain, which may result in neurodevelopmental deficits.[15] AAP and the ESPGHAN committee have summarised recommendations for the enteral feeding of premature and LBW infants. These recommendations aim to avoid the accumulation of nutrient deficits and to provide nutrients to sustain a similar growth and body composition to that of the foetus.[13,14] Although these recommendations exist, growth failure is still prevalent in premature and LBW infants.

A similar survey, aimed at paediatricians, was done in South Africa which aimed to determine enteral feeding practices in preterm infants.[32] This study included dietitians and investigated the knowledge, practices and perceptions of healthcare professionals. Including more healthcare professionals may help to identify differences in practices and opinions between different clinicians, by investigating and highlighting the perceptions of healthcare professionals' barriers or challenges to certain practices. It may also be possible to identify changes in practices from the two different surveys as well as differences in practices from surveys conducted in other countries, such as the Australian study by Patole, the international study by Dr Klingenberg and a 2006 neonatal nutrition survey by Dr Hans in America.[17,72,73]

Evidence exists that breastmilk is the enteral feed of choice for premature and LBW infants and reduces the risk of NEC and morbidity. Human milk, however, requires fortification to meet the high nutrient demands associated with prematurity. When mother's own milk is not available, fortified donor milk should be used.[37] Mixed feeding is not recommended in HIV-exposed infants due to the increased risk of HIV transmission.[61] The early introduction of enteral feeds may help to mature the immature gut of the premature infant, may reduce the number of parenteral nutrition days and reduce the number of days to meet full enteral feeding.[6,29,30]

KMC units are valuable and the use of intermittent or continuous skin-to-skin contact can be used as an alternative to incubators and radiators in resource-limited countries. Not only is the practice valuable for the infant, but it also provides positive psychological benefits to the

mother.[64,65] Standardised feeding protocols in neonatal units may serve as a method for reducing the risk of NEC and improve the feeding practices of premature and LBW infants.[69,70,71]

This study aimed to assess the knowledge, perceptions and practices of enteral feeding in premature and LBW infants among healthcare professionals involved in the treatment and management of premature and LBW infants in South Africa. This study may provide valuable information on disparities between knowledge, practices and perceptions, and may help to identify gaps that can be bridged to prevent growth failure, morbidity and mortality associated with prematurity. The results of the study could also be used for future research or the development of standardised infant feeding protocols for healthcare professionals.

CHAPTER 2

RESEARCH DESIGN AND METHODOLOGY

CHAPTER 2: RESEARCH DESIGN & METHODOLOGY

2.1 AIM AND OBJECTIVES OF THE STUDY

2.1.1 The aim of the study

The study aimed to determine the knowledge, perceptions and practices of healthcare professionals regarding enteral feeding (including breastfeeding, formula feeding, breastmilk fortifier and donor breastmilk) of premature and LBW infants in South Africa.

2.1.2 The study objectives (

2.1.3 Figure 2.1)

2.1.3.1 To determine the knowledge of healthcare professionals regarding enteral nutrition in premature and LBW infants in South Africa by:

i. Establishing the enteral feeding prescriptions provided to premature and LBW infants.
ii. Determining the initiation time of enteral feeds in terms of gestational age or birth weight and the rate of enteral feed progression.
iii. Comparing these variables with international recommendations.

2.1.3.2 To determine enteral feeding practices for premature and LBW infants by:

i. Evaluating the types of enteral feeds used (breastmilk, donor breastmilk, breastmilk fortifier, formula, or specialised formula).
ii. Comparing these variables with international recommendations.

2.1.3.3 To determine the perceptions and perceived role of healthcare professionals regarding enteral feeding in premature and LBW infants. This will include:

i. Perceptions on the feeding prescriptions and types of feeds.
ii. The perceived role of the doctor and the dietitian in the feeding of premature and LBW infants.

2.1.3.4 To compare enteral feeding practices concerning premature and LBW infants between government and private hospitals in South Africa.

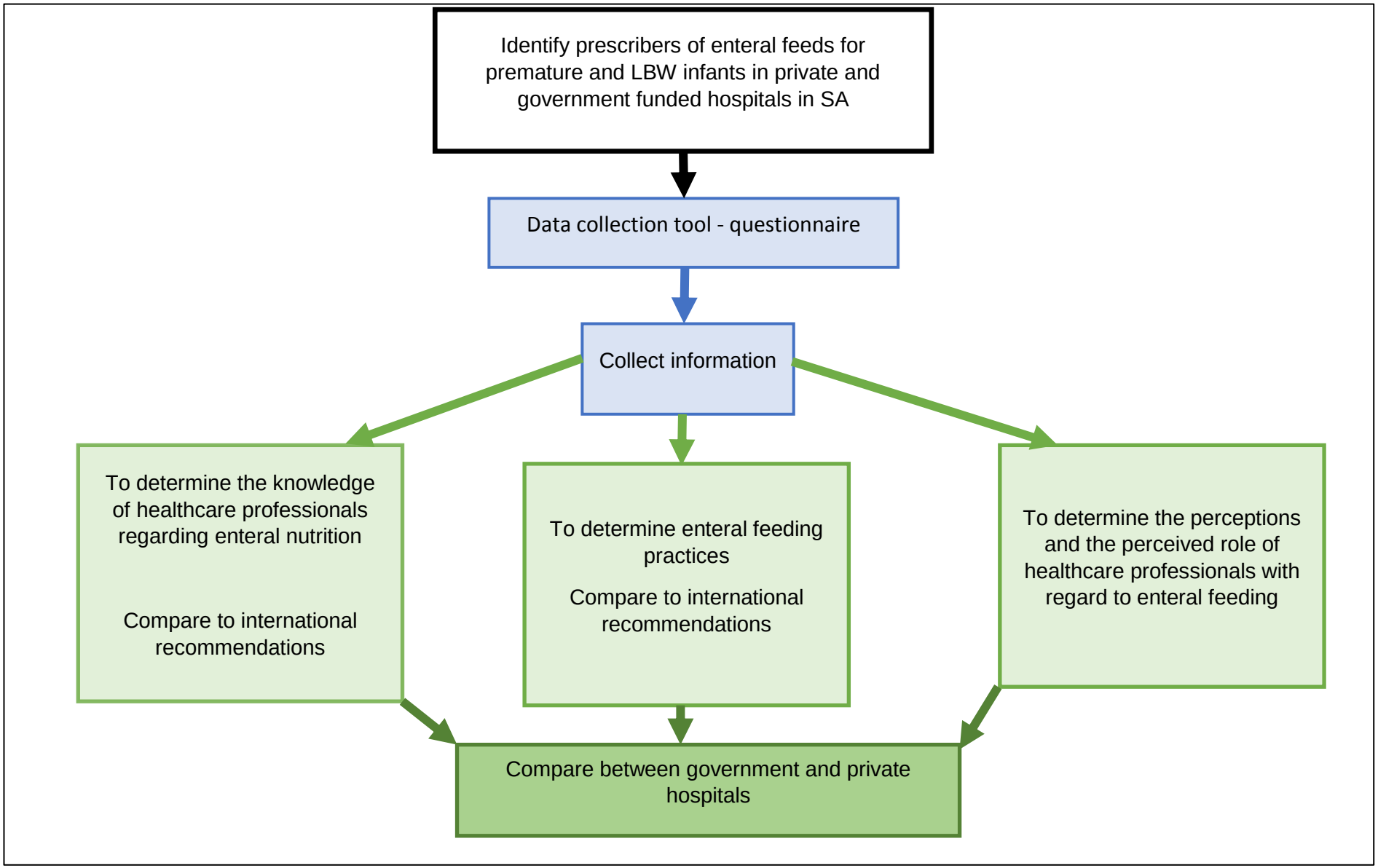

Figure 2.1: **Conceptual framework for achieving the study's aims and objectives**

2.1.4 Null hypotheses

The null hypotheses that directed the study was as follows:

i. There is no difference in the knowledge of healthcare professionals regarding enteral nutrition when compared with international recommendations.
ii. There is no difference in the enteral feeding practises of healthcare professionals when compared with international recommendations.
iii. There is no difference in the knowledge, perceptions and practices of healthcare professionals regarding enteral feeding of premature and LBW infants between privately-funded and state-funded hospitals in South Africa.

2.2 STUDY PLAN

2.2.1 Study design

An observational, descriptive, cross-sectional study with an analytical component was conducted.

2.2.2 Study population

The study population comprised healthcare professionals working in South African hospitals who were involved in the treatment and management of premature and LBW infants at the time of data collection. The healthcare professionals included doctors and dietitians.

2.2.3 Sample size

In South Africa, about 150 neonatologists and 160 dietitians work with premature and LBW infants. The required sample size was calculated by using a population of 314 with a 95% confidence interval and a 10% error. This calculation indicated that a sample size of 74 survey respondents was needed for the study.

2.2.4 Inclusion criteria

i. Identified prescribers of enteral feeds for premature and LBW infants were included in the study. For the purposes of this study, the “prescriber” was defined as a registered dietitian or doctor (not limited to paediatricians and neonatologists) prescribing feeds to premature and LBW infants on at least a weekly basis.

2.2.5 Exclusion criteria

The exclusion criteria applied in this study were:

i. Registered doctors and dietitians not identified as enteral feed prescribers for premature and LBW infants.
ii. Participants in the pilot study; and
iii. Healthcare workers who assisted with validating the questionnaire.

2.3 SAMPLING METHOD

Following ethics approval for the study from the Health Research Ethics Committee (HREC) of Stellenbosch University in May 2015, non-random purposive sampling was used to recruit study participants. A database of all of the hospitals and healthcare professionals and their contact details was compiled from Medpages and the Provincial Department of Health websites.

Hospitals involved in the treatment and management of premature and LBW infants were selected from the identified hospitals. These hospitals were contacted and the details of the healthcare professionals involved in the treatment and management of these infants was obtained. The survey link was e-mailed to the healthcare professionals who met the inclusion criteria.

Due to a poor response rate, an amendment to the protocol was made and approved by the HREC in February 2016. The amendment included distributing and advertising the survey to associations, forums, social media groups and committees involved with healthcare professionals who met the inclusion criteria. The advertisement was approved by the HREC committee (Appendix A). The survey was advertised on the website for the Association for Dietetics in South Africa (ADSA) and was distributed by the Gauteng Dietetics Clinical Forum and the South African Paediatric Association (SAPA).

A lucky draw to win a R4 000 sponsorship to attend a paediatric conference was offered to encourage responses. Participants interested in winning the prize or receiving the results of the study was requested to send their e-mail address to the principal researcher after completion of the survey.

2.4 METHODS OF DATA COLLECTION

2.4.1 Questionnaire

2.4.1.1 Questionnaire methodology

Permission was granted from Dr Claus Klingenberg to review the questionnaire used in an international survey that determined enteral feeding practices in preterm infants.[72] The web-based program, Survey Monkey, was used to develop the questionnaire online.

The questionnaire was designed by the principal investigator and was divided into the following sections:

- 1. Welcome to my survey
- 2. Background information
- 3. Facility background information
- 4. Timing and type of enteral feeds
- 5. Donor milk
- 6. Human milk fortifier
- 7. Mixed feeding
- 8. Discharge

The first section introduced and explained the survey and the informed consent process to the participants. The sections that followed contained general questions, knowledge questions, questions on the actual practices of the healthcare professionals and questions related to the healthcare professionals' perceptions and opinions of aspects of enteral feeding in premature and LBW infants (Appendix B). Recommendations by the AAP and ESPGHAN served as a reference for assessing their knowledge.[13,14]

2.4.1.2 Content validity

The questionnaire was reviewed by two experts in the field to determine content validity and whether the questions asked and the information that would be obtained were relevant to achieving the aims and the objectives of the study. Amendments were made to improve the questions and the general flow of the questionnaire.

2.4.1.3 Face validity

A pilot study was conducted to determine the face validity of the questionnaire, the average

time for completion and to obtain feedback and comments from the participants.

2.4.2 Pilot study

The principal investigator obtained six contact details of healthcare professionals who met the study's inclusion criteria. Pilot study participants were from the same geographical location as the principal investigator. A letter was drafted explaining the pilot study and an e-mail was generated using Survey Monkey and sent to the participants. Five out of the six participants completed the survey.

When three participants experienced problems answering the survey from the generated e-mail, a web link was created and e-mailed to the pilot study participants. This prompted the decision to use Survey Monkey to create a web link for the study.

Minor changes were made to the questionnaire after the pilot study. None of the pilot study participants were included in the data analysis.

2.4.3 Survey administration

After the pilot study had been completed a letter was drafted and an e-mail sent to the healthcare professionals with the web link to the survey. The introductory page of the survey explained the aims and objectives of the study as well as the informed consent process. By answering the survey, the survey participant was agreeing to informed consent due to the web-based nature of the study it was assured that confidentiality would be maintained.

An e-mail with the survey and the web link was also distributed to forums and associations aimed at healthcare professionals who met the inclusion criteria. ADSA as well as SAPA advertised the study to their participants. Respondents were given six months to complete the survey which opened in November 2015 and closed in May 2016.

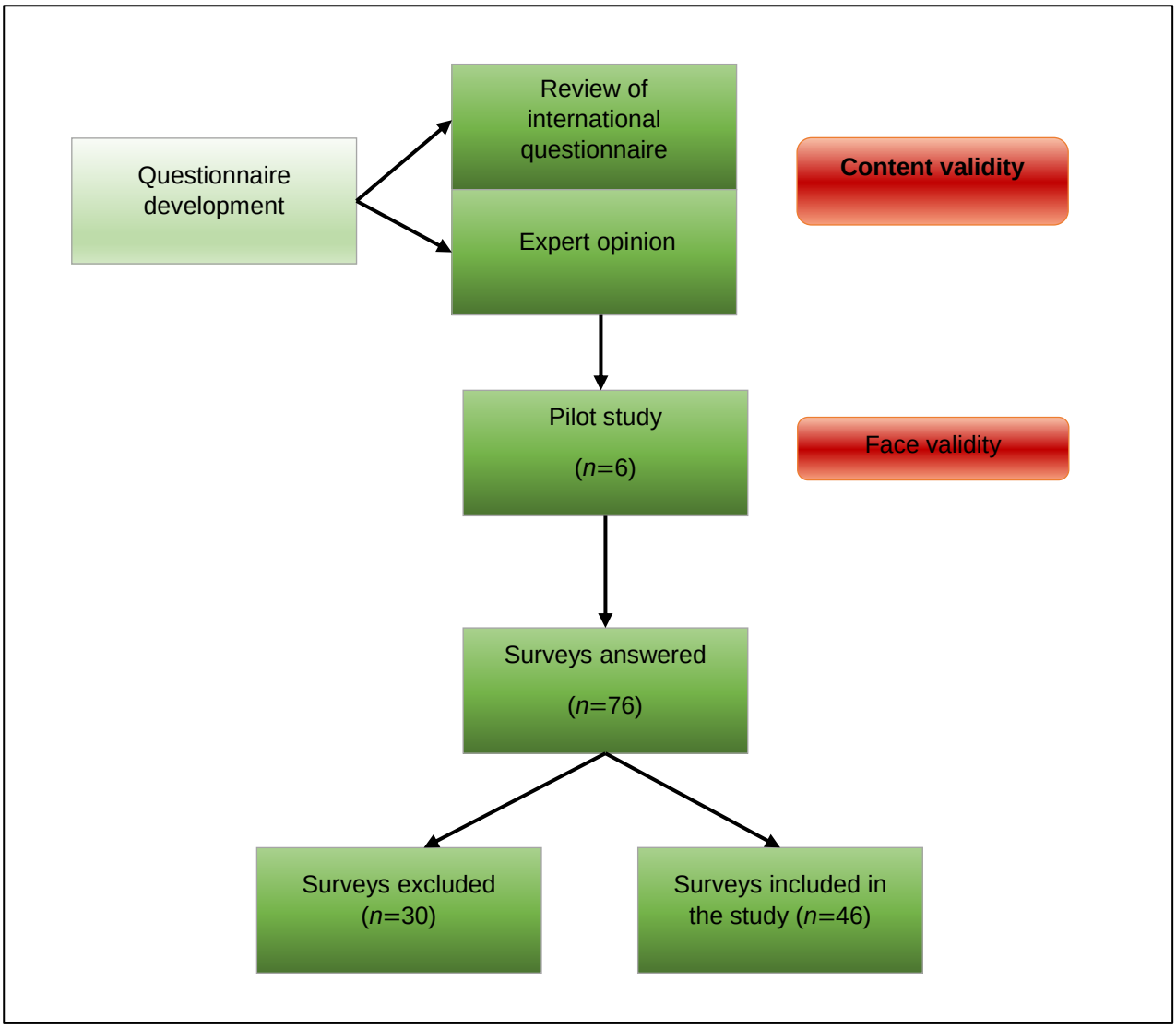

Figure 2.2: **Questionnaire development and study participants**

2.5 DATA ANALYSIS

2.5.1 Data management

Seventy-six healthcare professionals responded to the survey, thus meeting the required survey sample size of 74. Only 46 of the responses could be used for the data analysis as 30 surveys were only partially completed, having answered less than five questions.

The data obtained from the survey results was coded and entered into a Microsoft Excel 2016 spreadsheet. The qualitative data was categorised into themes and was reported under the results section.

2.5.2 Data analysis: Scoring of knowledge questions

Four questions were knowledge-based and were scored using ESPGHAN and AAP recommendations for enteral feeding of premature infants.[13,14]

The ESPGHAN and AAP guidelines were considered the most correct prescriptions.[13,14] Each knowledge question was scored from zero to two, with zero being outside of the guidelines and two being the most correct and within the guidelines.

The knowledge questions were scored as continuous variables and were compared between the two groups of healthcare professionals (doctors and dietitians) and between the healthcare providers (government and private). These comparisons were done using unpaired *t*-tests.

2.5.3 Statistical analysis

IBM SPSS version 23 was used to analyse the data. Nominal and binary variables were summarised using frequency tables and relative frequencies. Tables and bar graphs stratified by groups were used to summarise data and to represent it graphically.

Most of the questionnaire items were analysed individually for associations between the groups of healthcare professionals (doctors and dietitians) and between the healthcare providers (public and private). Pearson's chi-square tests were used for these comparisons.

Practices were treated as categorical variables and Pearson's chi-square tests were used to assess factors associated with the selected practices.

A p value < 0.05 was considered to be statistically significant.

Some belief and perception questions had a variety of response options and some questions were qualitative and open-ended. The open-ended questions were categorised into familiar themes. The responses to these questions are summarised in supplementary tables.

2.6 ETHICAL AND LEGAL ASPECTS

Ethical approval was granted by the HREC of the Faculty of Medicine and Health Sciences, Stellenbosch University in May 2015 (S14/10/253). Amendments made to the original protocol were approved by the HREC in February 2016.

In the first part of the questionnaire, the research project was explained to participants who were advised that by answering the questions they were granting informed consent.

Because the survey was anonymous, responses could not be linked to any particular participant, thus ensuring confidentiality.

To improve the response rate, participants were invited to take part in a lucky draw for a R4 000 sponsorship to attend a paediatric or neonatal conference of the winner's choice. Participants who chose to enter the lucky draw and receive feedback on the study sent their contact number and e-mail address to the principal investigator. The principal investigator kept all information confidential and participants who sent their names and contact details were known only to the principal investigator.

For statistical purposes, the participant was required to indicate the hospital at which they were working. The reason for this was to avoid a cluster effect which could be construed as bias. A code system was used to keep the hospitals' details confidential.

Password-protected folders on a password-protected computer were used to keep all electronic data secure. Any printed or hard copies of the data were locked in a filing cabinet. The data will be kept secure by the principal researcher for five years.

CHAPTER 3

RESULTS

CHAPTER 3: RESULTS

The results section is reported in the format of an article which will be submitted for publication to a peer-reviewed journal.

ARTICLE

The Knowledge, Perceptions and Practices of Healthcare Professionals Regarding Enteral Feeding of Premature and Low Birth Weight Infants in South Africa

Bradfield Margot L[1], van Niekerk Evette[1], du Preez J CF[2].

[1]Division of Human Nutrition, Faculty of Medicine and Health Sciences, Stellenbosch University, PO Box 241, CAPE TOWN 8000. Suid-Afrika/South Africa. Tel: +27 21 938-9474; Fax: +27 21 933-2991

[2] Department of Pediatrics and Child Health, Division of Neonatology, Faculty of Medicine and Health Sciences, Stellenbosch University, Tygerberg, South Africa

Correspondence to: Margot Bradfield: bradfieldml@gmail.com

ABSTRACT

Prematurity is the leading cause of death in children under five years of age, and the incidence of prematurity is increasing. Determining the knowledge, perceptions and practices of healthcare professionals regarding the enteral feeding of premature infants may provide valuable information for reducing morbidity and mortality in this vulnerable group.

A descriptive cross-sectional study with an analytical component was conducted and the study population comprised doctors and dietitians from the public and private sectors who are involved in the care and management of premature and low birth weight (LBW) infants.

A significant difference was observed for the initiation time of enteral feeds for very low birth weight (VLBW) infants between government and private sector facilities ($p = 0.025$). There was a significant difference between doctors and dietitians ($p = 0.039$) with respect to full enteral feeding volume, and a significant difference ($p = 0.036$) was noted between doctors and dietitians on whether nutrients are calculated in their facilities. Significantly more ($p = 0.05$) dietitians ($n = 16$, 76.2%) calculated the protein requirements in their facilities than doctors ($n = 9$, 36%). The energy prescriptions between the government and private sectors for each birth weight category differed [extremely low birth weight (ELBW) infants ($p = 0.038$), VLBW infants ($p = 0.027$), $< 2\,000$ g ($p = 0.019$), $< 2\,500$ g ($p = 0.045$)]. A significant difference was found between professions and the daily protein prescriptions for ELBW infants ($p = 0.037$), the less than 2 000 g ($p = 0.024$) and the LBW ($p = 0.013$) category. Doctors' and dietitians' responses differed for who is responsible for discharge education ($p = 0.024$). Significantly more doctors prescribed micronutrients on discharge than dietitians. Beliefs and perceptions were in line with current evidence and recommendations and reflect the practices of healthcare professionals.

In this study, differences existed between certain practices between healthcare professionals as well as between hospital sectors. A significant difference was not seen among healthcare professionals between the total knowledge scores and the recommendations. Larger studies are needed to confirm these findings and the reasons for these differences.

INTRODUCTION

Annually, approximately 15 million infants are born premature and prematurity is the leading cause of death in children under five years of age. With advancements in medicine and research, survival rates of premature infants have increased significantly, particularly in developed countries. As countries advance, survival rates of premature infants will also improve, which may increase the morbidity associated with prematurity.[1,2,3] More than 60% of premature births occur in Africa and South East Asia. About 9% of infants are born premature in higher income countries, compared with 12% in lower income countries.[1,4]

Recommendations are available from the European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) committee and the American Academy of Pediatrics (AAP) for the enteral feeding of VLBW premature infants. Limited recommendations are available for microprems (birthweight <800g) or infants with an ELBW. Although recommendations exist, postnatal growth failure is still prominent in premature infants.

Investigating the knowledge, perceptions and practices of healthcare professionals responsible for prescribing enteral nutrition in South African government and private hospitals may identify gaps or discrepancies that will help to prevent future postnatal growth failure in this vulnerable group.

METHODOLOGY

A descriptive cross-sectional study with an analytical component was conducted from November 2015 until May 2016. The study took the form of an online survey using the web-based program, Survey Monkey. The study population comprised doctors and dietitians from the public and private sectors who are involved in the care and management of premature and LBW infants.

An e-mail was sent to healthcare professionals, providing a web link to the survey. An e-mail with the survey and the web link was also distributed to forums and associations aimed at healthcare professionals who met the inclusion criteria.

The questionnaire contained general questions, knowledge questions, questions on

healthcare professionals' practices and questions related to healthcare professionals' perceptions and opinions of aspects of enteral feeding in premature and LBW infants. The questionnaire included multiple choice and open-ended questions.

Content validity was ensured by a review from two experts in the field. A pilot study was conducted to determine the face validity of the questionnaire, the average time for completion and to obtain feedback and comments from the participants.

ESPGHAN and AAP guidelines were considered to be the most correct prescriptions. [13,14] Each knowledge question was scored from zero to two, with zero being outside of the guidelines and two being the most correct and within the guidelines.

Statistical analysis

IBM SPSS version 23 was used to analyse the data. Questionnaire items were mainly analysed individually for associations between healthcare professionals and the healthcare sectors. Pearson's chi-square tests were used for these comparisons. The knowledge questions were scored as continuous variables, which were compared between the two groups of healthcare professionals and between the healthcare providers. These comparisons were done using unpaired *t*-tests.

Practices were treated as categorical variables and Pearson's chi-square tests were used to assess factors associated with the selected practices. For all comparisons, a *p*-value of less than 0.05 was considered statistically significant.

Some perception questions had a variety of response options and some questions were qualitative and open-ended. The open-ended questions were categorised into familiar themes.

RESULTS

A total of 76 participants started the survey, 30 (39%) of whom completed fewer than five survey questions and were excluded from the data analysis. The final sample comprised 46 participants.

Demographic Characteristics

The demographic characteristics of the respondents and the facilities characteristics are summarised in Table 1 and Table 2.

Table 1: Demographic characteristics of the survey respondents

Profession (*n* = 46)	***n***	**(%)**
Doctor	**25**	**54.3**
–Medical officer	1	4
–Paediatrician	16	64
–Neonatologist	8	32
Dietitian	**21**	**45.7**
–Registered dietitian	17	81
–Community service dietitian	4	19
Hospital sector (*n* = 46)	***n***	**(%)**
Government	**34**	**73.9**
Private	**12**	**26.2**
Province where hospital is located (*n* = 46)	***n***	**(%)**
Eastern Cape	7	15.2
Free Sate	0	0
Gauteng	19	41.3
KwaZulu-Natal	3	6.5
Limpopo	0	0
Mpumalanga	1	2.2
North West	4	8.6
Northern Cape	2	4.3
Western Cape	10	21.7
KMC unit (*n* = 46)	***n***	**(%)**
Yes	32	69.6
No	14	30.4
Standardised infant feeding protocol (*n* = 46)	***n***	**(%)**
Yes	31	67.4
No	11	23.9
Not sure	4	8.7
Access to donor milk (*n* = 44)	***n***	**(%)**
Yes	**32**	**73**
–Own breastmilk bank	14	43.8
–External source	18	56.3
No	**12**	**26**
Infant feeding information received from (*n* = 46)	***n***	**(%)**
Medical delegates/representatives from companies	6	13
Workshops and CPD events	11	23.9
Journal articles and current evidence	23	50
University/medical school	5	10.9
Other (specify)	1	2.2

Table 2: Number of neonatal beds

Number of ICU or HCU beds	Total institutions	Median (IQR)
ICU beds (*n* = 44)	**Total institutions,** Government hospitals Private hospitals	**6 (2–12)** 6 (2–10) 9 (3–12)
HCU beds (*n* = 46)	**Total institutions** Government hospitals Private hospitals	**6 (4–12.75)** 6 (4–16) 3 (3–10)

Enteral feeds: initiation time and type of feeds

The initiation time and type of enteral feeds were stratified according to birth weight or gestational age and showed a positive trend. Infants born with an ELBW were more likely to be started on enteral feeds within the first 24 hours of life by doctors (52%, $n = 13$) than by dietitians (47.6%, $n = 10$). Human milk was the enteral feed of choice for all doctors ($n = 25$) and for most dietitians (90.5%, $n = 19$) for ELBW infants. Two dietitians working in government hospitals initiated dextrose water as the enteral feed of choice for infants in this birth weight category.

Most doctors (80%, $n = 20$) and dietitians (61.9%, $n = 13$) would initiate enteral feeds for VLBW infants within the first 24 hours of life and human milk (mother's own or donor milk) was the enteral feed of choice for all respondents ($n = 46$).

LBW infants were likely to start enteral feeds within the first 24 hours of life and human milk was the feed of choice among all respondents ($n = 46$).

A significant difference in the initiation time of enteral feeds for VLBW infants was observed between government and private sectors ($p = 0.025$). In the government sector, it was more common in VLBW infants for feeds to be initiated earlier and within 24 hours of life. Two dietitians (16.7%) from the private sector indicated that enteral feeds were initiated based on the paediatrician's instructions.

Trophic feeding

Trophic feeding practices are illustrated in Table 3. Trophic feeding was defined in the questionnaire as feeding with small volumes of 0.5–1 ml/kg/day up to a maximum of 20 ml/kg/day. Most doctors and dietitians attempt to increase the enteral feed volume daily for all birth weight categories. No significant difference was seen between doctors and dietitians or between the government and public sector for the advancement of trophic feeds.

Table 3: Trophic feeding

Trophic feeding							
Total respondents $n = 44$		Healthcare professional			Type of hospital		
		Doctor	Dietitian	*p*-value	Government	Private	*p*-value
< 28 weeks (< 1 000 g)	Minimal trophic feeding for less than 4 days	6 (26.1%)	5 (23.8%)	0.606	9 (27.3%)	2 (18.2%)	0.195
	Minimal trophic feeding for more than 4 days	1 (4.3%)	0		0	1 (9.1%)	
	Attempt to increase the volume on a daily basis	16 (69.6%)	16 (76.2%)		24 (72.7%)	8 (72.7%)	
< 31 weeks (< 1 500 g)	Minimal trophic feeding for less than 4 days	3 (13%)	4 (19%)	0.558	6 (18.2%)	1 (9.1%)	0.180
	Minimal trophic feeding for more than 4 days	1 (4.3%)	0		0	1 (9.1%)	
	Attempt to increase the volume on a daily basis	19 (82.6%)	17 (81%)		27 (81.8%)	9 (81.8%)	
< 37 weeks (< 2 500 g)	Minimal trophic feeding for less than 4 days	2 (8.7%)	3 (14.3%)	0.560	5 (15.2%)	0	0.170
	Minimal trophic feeding for more than 4 days	0	0		0	0	
	Attempt to increase the volume on a daily basis	21 (91.3%)	18 (85.7%)		28 (84.8%)	11 (100%)	

P-value of < 0.05 is statistically significant

Clinical conditions for delaying enteral feeding

The most common reason for delaying enteral feeds was significant perinatal asphyxia (n =34, 73.9%). Respondents from the government sector (n = 27, 79.4%) were more likely than those from the private sector (n = 7, 58.3%) to delay feeds for this reason. Twenty doctors (80%) and 14 dietitians (66.7%) stated that they would delay enteral feeds under this condition.

Severe hypotension was the second most common reason for delaying enteral feeds. Respondents from government facilities (n = 21, 61.8%) were more likely to delay enteral feeds for this reason than private facilities (n = 5, 41.7%). Doctors (n = 17, 68%) were more likely to delay feeds for this reason than were dietitians (n = 9, 42.9%).

Fifteen respondents (32.6%) specified reasons other than the options provided in the questionnaire (restricted growth, reverse end-stage diastolic flow in umbilical artery, meconium not yet passed and in-dwelling umbilical arterial catheter) for delaying enteral feeds. These reasons were categorised and included congenital abnormalities, bowel obstruction, severe respiratory distress, inadequate maternal milk supply, an HIV-exposed infant where the feeding choice of the mother was not yet established, severe abdominal distension, and necrotising enterocolitis.

There was no significant difference between reasons given by healthcare professionals or healthcare sectors for delaying the initiation of enteral feeds.

Nutrients calculated

A significant difference was seen between doctors and dietitians (p = 0.039) with regard to the full enteral feeding volume. The majority of doctors (n = 18, 72%) considered 161–180 ml/kg/day to be the full enteral feeding volume, while only six dietitians (28.5%) considered this to be the case. Of the remaining dietitians, eight (38.1%) indicated that the typical full enteral feeding volume was 181–200 ml/kg/day, and five (23.8%) selected the 140–160 ml/kg/day category.

Twenty (58.8%) of the healthcare professionals from government facilities indicated that specific nutrients are calculated when enteral feeds are prescribed in their facilities and three (27.3%) healthcare professionals from private facilities indicated the same. Of these respondents, eight doctors (33.3%) and 15 dietitians (71.4%) indicated that specific nutrients

are calculated in the institution where they work. A significant difference ($p = 0.036$) was noted between doctors and dietitians.

The first follow-on question relating to whether nutrients are calculated in the facility, enquired about whom was responsible for calculating the nutrients. Twenty-eight (60.9%) respondents answered the question although only 23 indicated that specific nutrients are calculated in their facilities. Four doctors (33.3%) and thirteen dietitians (81.3%) indicated that they were responsible for calculating the nutrient requirements themselves. Five doctors (41.7%) indicated that the dietitians are responsible for calculating the nutrient requirements for premature and LBW infants in their facilities. In summary, the results reveal that more dietitians than doctors are inclined to calculate the nutrient requirements in their facilities.

The majority of the respondents indicated that daily energy and protein levels are calculated [$n = 26$ (93%) and $n = 25$ (89%) respectively]. Significantly more dietitians ($n = 16$,76.2%) calculate the protein requirements than doctors ($n = 9$, 36%; $p = 0.05$). Approximately half of the respondents indicated that the daily carbohydrate and fat requirements are calculated at their facilities [$n = 15$ (54%) and $n = 16$ (57%) respectively]. Six respondents (21%) included other nutrients such as micronutrients, trace elements and electrolytes. Twenty-seven (58.7%) respondents answered the question, even though only 23 indicated that specific nutrients are calculated in their facilities.

Enteral feeding prescriptions

Energy and protein prescriptions were stratified according to the infant's birth weight or gestational age. The majority of doctors and dietitians chose an enteral target energy of 100–135 kcal/kg/day for all birth weight categories. A significant difference was found in the energy prescriptions between government and private sector facilities for each birth weight category for ELBW infants ($p = 0.038$), for VLBW infants ($p = 0.027$) and for both LBW categories ($< 2\,000$ g, $p = 0.019$; $< 2\,500$ g, $p = 0.045$).

For each birth weight category, two doctors (8.3%) specified their answers. One doctor was unsure of the energy and protein prescriptions for each category, while another indicated that energy and protein needs to be calculated and individualised to each specific case. One respondent indicated that the presence of bronchopulmonary disease (BPD) should be taken into consideration when prescribing energy for premature and LBW infants.

The protein prescriptions were more varied for each birth weight category and healthcare profession than the energy prescriptions. A trend was seen for healthcare professionals to prescribe less protein for ELBW infants than the recommended requirements, with only three doctors (12.5%) and twelve dietitians (57.1%) selecting the highest prescription of 3.5–4.5 g/kg/day of protein. A significant difference was found between professions and the daily protein prescriptions of ELBW infants ($p = 0.037$).

Doctors were more likely to prescribe 2.5–3 g/kg/day ($n = 10$, 41.7%) of protein while dietitians were more likely to prescribe 3–3.5 g/kg/day ($n = 8$, 38.1%) of protein for infants born with a VLBW.

For infants weighing less than 2 000 g, the trend was for doctors to prescribe 2.5– 3 g/kg/day ($n = 10$, 41.7%) of protein while dietitians prescribed 3–3.5g/kg/day ($n = 7$, 33.1%) and 3.5–4g/kg/day ($n = 7$, 33.1%) of protein. There was a statistically significant difference between doctors' and dietitians' protein prescriptions for these infants ($p = 0.024$).

In the highest birth weight category (2 500 g), a significant difference was evident where doctors tended to prescribe the lower ranges of protein prescriptions [2.5–3 g/kg/day of protein ($n = 10$, 43.5%) dietitians prescribed higher protein ranges 3.5–4 g/kg/day ($n = 7$, 33.3%) ($p = 0.013$).

Knowledge-based questions

Thirty-seven participants answered the knowledge-based questions. These questions focused on the initiation time and type of enteral feeds and the typical target energy and protein prescriptions for stable, premature infants. The questions were stratified according to weight or gestational age categories. No significant difference was found for the knowledge scores of the healthcare professionals.

Maternal feeding choice and HIV exposure

The mother's infant feeding choice was considered by the majority of healthcare professionals working in both government ($n = 29$, 85.3%) and private ($n = 9$, 75%) facilities. This was also evident by profession, with the majority of dietitians ($n = 18$, 85.7%) and doctors ($n = 20$, 80%) considering the mother's infant feeding choice when prescribing feeds.

Forty-one (89%) of the respondents indicated that the infant's exposure to HIV was taken into account when deciding on the type of enteral feed initiated. Almost all the doctors ($n =$ 23, 92%) and dietitians ($n = 18$, 85.7%) considered HIV exposure. Of these healthcare professionals, 21 (45.7%) recommended breastmilk if the infant was HIV-exposed. A significant difference ($p = 0.04$) was identified between government and private sectors. Twenty (58.5%) respondents from the government sector and one (8.3%) from the private sector stated that they would advise mothers of HIV-exposed infants to breastfeed. One (2.2%) respondent recommended infant formula and 21 (45.7%) advised mothers to make an informed decision. Two of the respondents who advised mothers to breastfeed recommended pasteurised breast milk, while one respondent recommended donor breastmilk.

Donor milk

Fourteen (31.9%) respondents who answered the question regarding access to donor breastmilk indicated that they had breastmilk banks at their facilities. Most breastmilk banks were in government facilities ($n = 12$, 85.7%) and there were two (14.3%) breastmilk banks in private facilities. Eighteen (40.9%) respondents indicated that they have access to donor breastmilk from external sources, the majority of which ($n = 14$, 77.8%) were from government facilities and four (22.2%) from private facilities. Of the 12 (27.2%) respondents that did not have access to donor breastmilk, eight (93.9%) were government facilities and four (33.3%) were private facilities. One respondent indicated that their facility is more than 300 km away from cities that have breastmilk banks. A significant difference was not seen with regard to access to donor breastmilk between the public and private hospital sector ($p = 0.512$).

The most frequently selected criterion used to prescribe donor milk was insufficient production of mother's own milk ($n = 24$, 92%). Of these responses, 18 (75%) were from government facilities and six (25%) from private facilities. Weight was the second most frequent criterion ($n = 23$. 88%), with 19 (82.3%) healthcare professionals from government and four (17.3%) from private facilities using the infant's weight for prescribing donor milk. Maternal illness was the third most commonly chosen criterion for prescribing donor milk ($n = 22$, 84.6%), of whom 18 (81.2%) respondents were from government and four (18.2%) from private facilities. HIV exposure and multiple births ($n = 15$, 57.7%) were the fourth most frequently selected criteria for prescribing donor milk. For both of these criteria, 12 (80%) of the respondents were from government and three (20%) were from private facilities. The

criterion of an orphaned infant was selected by 13 respondents (50%), with 11 (84.6%) from government and two (15.4%) from private facilities. Four (15.4%) healthcare professionals selected the option “other” and of these, three (75%) indicated that gestational age was used as a criterion for prescribing donor milk, while one (25%) respondent indicated that donor milk is only used for LBW infants.

Human milk fortifier

Forty-two (95%) of the 44 respondents who answered the survey question indicated that they used human milk fortifier in their facilities. Twenty-one (50%) respondents initiated human milk fortifier at full strength (1 scoop in 20 ml), 15 (35.7%) at half strength (½ scoop in 20 ml), and three (7.1%) started with quarter strength (¼ scoop in 20 ml), while two (4.8%) were unsure of the initiation strength of human milk fortifier. Two (4.8%) respondents specified their answers: one indicated that the lower the gestational age of the infant, the lower the initiation strength of the human milk fortifier; the other specified that they initiated human milk fortifier in 30–35 ml of human milk per feed.

Mixed feeding

Most of the respondents indicated that mixed feeding does not routinely occur in their facility ($n = 28$, 62.2%), while 15 respondents (33.3%) indicated that mixed feeding does occur routinely in their facility. Two respondents (4.4%) were unsure.

Most of the respondents ($n = 38$, 82.6%) used a form of top-up measure for ELBW infants when the mother’s own milk was not sufficient. Donor milk was the most commonly used top-up measure ($n = 28$, 60.9%). Government facilities used donor milk more often ($n = 22$, 64.7%) than the private sector ($n = 6$, 50%). Significantly more doctors ($n = 19$, 76%) than dietitians ($n = 9$, 42.9%) indicated that donor milk was used as a top-up measure for ELBW infants ($p = 0.022$).

For infants in the VLBW category, the majority of respondents indicated that top-up measures were used ($n = 41$, 89,1%) if the mother’s own milk was not sufficient. Donor milk was used most frequently as a top-up measure in both government ($n = 20$, 58.8%) and private ($n = 6$, 50%) facilities. Nineteen doctors (68%) and nine (42.9%) dietitians specified that donor milk was used as a top-up measure for VLBW infants.

Top-up measures were also used by most of the respondents ($n = 41$, 89.1%) for both of

the LBW categories. Powdered preterm formula was used more often (*n* = 16, 34.8%) for infants weighing less than 2 000 g compared with other products, particularly in government facilities (*n* = 13, 38.2%). Donor milk was the second most commonly used top-up measure for infants weighing less than 2 000 g (*n* = 13, 28.3%), particularly in private facilities (*n* = 10, 29.4%). For infants with a higher birth weight (< 2 500 g) powdered term (*n* = 11, 23.9%) and preterm formulas (*n* = 11, 23.9%) were used the most frequently. Powdered preterm and term formula was used more often in government facilities (*n* = 9, 26.5%) than in private facilities (*n* = 2, 16.7%), while ready-to–use (RTU) preterm formula was used more often in private facilities (*n* = 4, 33.3%).

A trend was seen for top-up measures to be used for all birth weight categories. Donor milk was used for smaller infants, while powdered term and preterm formulas were used more regularly in government facilities, and RTU preterm formulas in private facilities for infants in the LBW category. More doctors were inclined to use donor breastmilk in ELBW and VLBW compared with dietitians.

Discharge education and supplementation

The greatest proportion of respondents (*n* = 16, 36.4%) indicated that doctors, dietitians and nurses are involved in providing information on infant feeding before discharge. A significant difference was seen between the doctors' and the dietitians' responses (*p* = 0.024). More doctors (*n* = 10, 41.7%) than dietitians (*n* = 6, 30%) indicated that all three healthcare professionals are involved in providing infant feeding education. Five respondents (11.4%) specified their answers: one indicated that the dietitian is not routinely involved in the care of premature infants prior to discharge; two indicated that the nurse and the doctor are the only healthcare professionals involved in infant feeding education before discharge; one indicated that the general paediatrician provides education on infant feeding; and one respondent indicated that the nurse and dietitian provide infant feeding information.

Most respondents (*n* = 34, 73.9%) recommend iron (not as part of a multivitamin) on discharge. A difference was seen between doctors' and dietitians' responses, with 24 doctors (96%) and 10 dietitians (47.6%) recommending an iron supplement (not as part of a multivitamin). Twenty-five (54.3%) respondents recommend vitamin D (not as part of a multivitamin), from the private sector (*n* = 9, 75%) and 16 respondents (47.1%) from the public sector. More doctors (*n* = 18, 72%) than dietitians (*n* = 7, 33.3%) recommended

Vitamin D. Thirty-five (76.1%) respondents recommended a multivitamin. Four dietitians (19%) indicated that they did not recommend any supplements on discharge and a significant difference was seen between doctors and dietitians ($p = 0.022$). Eight respondents (17.4%) specified that they recommend other supplements including probiotics, folate and a protein or fat supplement.

Perceptions and perceived role of healthcare professionals regarding enteral feeding

The questions asked to determine the perceptions and summaries of the answers are presented in supplementary tables.

The majority of the participants (93.5%, $n = 43$) perceive the optimal choice of enteral nutrition in the neonatal unit to be human milk (mother's own/donor milk).

There were a variety of responses from different healthcare professionals concerning their views on the safety of using infant formula in the neonatal unit. Twenty participants (45.5%) agreed with the statement that infant formula is safe to use in the neonatal unit, 14 (31.8%) healthcare professionals did not agree and 10 (22.7%) specified their views. Thirteen (31%) healthcare professionals agreed with the statement that infant formula is not safe to use in the neonatal unit, while 19 (45.2%) did not agree and 10 (23.8%) specified their own views.

When asked to give their opinions of RTU infant formula compared with powdered infant formula, most respondents ($n = 36$, 78.8%) felt that powdered infant formula had more safety risks than RTU formula.

The majority of respondents ($n = 39$, 86.7%) felt that neurological outcomes would be negatively affected if specific nutrient requirements were not met. The majority of healthcare professionals ($n = 32$, 82.2%) also felt that it was necessary to calculate specific nutrients for premature infants.

Most respondents indicated that doctors ($n = 33$, 71.7%), nurses ($n = 33$, 71.7% and dietitians ($n = 37$, 80.4%) should be responsible for providing information to the mother for making an informed decision with regard to feeding options.

Almost all the healthcare professionals ($n = 44$, 97.8%) consider donor milk to be

acceptable. Fourteen (31.8%) of the respondents feel that donor milk is accepted by mothers while 18 (40.0%) believe that mothers do not find donor milk acceptable.

The qualitative questions were categorised into themes (supplementary table). When asked to describe how they felt about the practice of using only fluid volumes to calculate specific nutrients, seven main themes were identified. One participant wrote, “It is a waste of time calculating as no individualised supplements are available in state facilities”. The following themes were found:

- “It is fine to use if the infant is growing adequately”
- “It is not accurate and not the correct practice”
- “Nutrient requirements should be calculated”
- “If there is no dietitian, it is practical for the setting”
- “Nutrient requirements are not worth calculating as there are no supplements available in the government setting”
- “It is difficult to calculate nutrient requirement for expressed breastmilk”
- “It is safe and practical”

The respondents were asked their opinions on the life-saving potential of human milk for premature and LBW infants. The majority ($n = 39$, 95.1%) had a similar response that was categorised as “breastmilk has life-saving potential”. One respondent indicated that the mother’s own milk is optimal and donor breastmilk is less suitable. Another respondent wrote that “it has life-saving potential but is not a viable option”.

When asked to describe their beliefs on the use of human milk fortifier, the general perception was that it is essential in the care of premature infants ($n = 38$, 82.6%).

Twenty-two respondents (47.8%) felt that mixed feeding increases morbidity and mortality.

DISCUSSION

The majority of the respondents (73.9%) were from the government sector while only 29.2% were from the private sector. An over-representation of certain provinces was also found as none of the respondents were from the Free state or Limpopo while 41.3% were from Gauteng and 21.7% were from the Western Cape.

The provision of adequate nutrition is essential for premature and LBW infants. Poor nutrition during the early stages of life reduces growth including brain growth and may result in neurodevelopmental deficits.[15,74,75]

The survey results indicate that the majority of clinicians, particularly in the government sector, initiate enteral feeds within the first 24 hours after birth for all premature and LBW infants, with the remainder initiating enteral feeds within the first 48 hours after birth. This confirms the data from a South African study published in 2013[32] and is in line with international recommendations by AAP who endorse the early initiation of enteral feeds for VLBW infants.[14] Delayed initiation of enteral feeds may be associated with the development of NEC and late onset sepsis.[3,14,29]

Human milk, particularly the mother's own milk, was the feed of choice for the majority of clinicians, which is line with AAP and ESPGHAN recommendations.[13,39] The perception amongst the clinicians was that human milk has life-saving potential for this vulnerable group of infants.

Enteral feeding in premature infants is usually started by means of trophic feeds in order to prime the gut and evaluate the infant's tolerance to enteral nutrition. The majority of healthcare professionals who took part in the survey aimed to increase trophic feeds among all birth weight categories on a daily basis.

The most common reasons for delaying the onset of enteral feeds was significant perinatal asphyxia and severe hypotension. These reasons were similar to those of the earlier South African study, but in this study the second most common reason was the unavailability of human milk.[32]

An unexpected finding was that most clinicians did not prescribe sufficient energy for ELBW infants to meet their nutritional requirements. AAP recommends an energy intake of 130–150 kcal/kg/day for ELBW infants, while the respondents selected the prescription of 100–135 kcal/kg/day.[38] In the case of VLBW infants, most respondents selected the category 100–135 kcal/kg/day, which is in line with ESPGHAN and AAP guidelines. For the LBW infants, most of the clinicians prescribed an adequate amount of energy of between 110 and 135 kcal/kg/day. A significant difference was seen between the government and the private sector with respect to energy prescriptions. Doctors and dietitians had

significantly different protein prescriptions across all birth weight categories. The majority of doctors selected a prescription below recommendations for all of the birth weight categories, while most dietitians selected protein requirements within the recommendations.

Overall there was no significant difference with regard to the knowledge scores between and within groups.

Significantly more dietitians felt that 181–200 ml/kg/day was considered the typical full enteral feeding volume, compared with doctors who considered 161–180 ml/kg/day to be the full enteral feeding volume. The fluid volume specified by the doctors is similar to the findings of the South African study as well as the international survey by Dr Claus Klingenberg.[72] ESPGHAN recommends 150–180 ml/kg/day of fortified breastmilk or infant formula. Of the respondents, 95% indicated that they used human milk fortifier and 82.6% felt that human milk fortifier was essential for premature infants.[13] This may be of interest as a larger proportion of clinicians indicated that they use human milk fortifier than has been indicated in previous studies.

Although the doctors indicated that they prescribe lower protein quantities, they indicated that a fluid volume of 161–180 ml/kg/day should be the goal. If the majority of doctors use human milk fortifier at the indicated fluid volume, it is plausible that the majority of ELBW and VLBW infants will meet their nutritional requirements for energy. Most clinicians felt that it is important to calculate nutrient requirements and not use fluid volumes to prescribe enteral feeds. The results from the study indicate that dietitians are more inclined to calculate the nutrient requirements, and significantly more dietitians tend to calculate the protein requirements. Therefore, an interdisciplinary approach between the doctor, dietitian and nursing staff is essential in the neonatal unit to ensure the adequate provision of nutrient requirements.

The infant's exposure to HIV was considered by the clinicians, which is important in the South African context considering the high rate of HIV infection. In South Africa, current state guidelines for HIV contra-indicating breastfeeding is a viral load of 1 000 units and a mother on third-line ARV therapy.[63] If the mother is compliant with her treatment and does not fall within these parameters, breastfeeding is generally still the enteral feed of choice. Almost half the responses indicated that mothers should be advised to breastfeed while almost half advised that the mother be provided with information to make an informed

decision. Significantly more clinicians in the government sector than in the private sector would advise a mother of an HIV-exposed infant to breastfeed. In the government sector, infant feeding options are discussed during antenatal clinic visits.[63] Premature infants are often born to mothers who have not started or who have not completed all their antenatal clinic visits. It is, therefore, imperative for healthcare professionals in the neonatal unit to provide infant feeding information to the mother. This information should be consistent between the disciplines and should assist the mother in making an informed decision.

Mixed feeding of the mother's milk and formula should be avoided in HIV-exposed infants as it has been shown to increase the risk of HIV transmission.[61] In the majority of facilities, mixed feeding was not a routine practice and about half of the clinicians felt that mixed feeding may increase the risk of morbidity or mortality.

If the mother's own breastmilk was not available, top-up measures were used by most clinicians for all birth weight categories. Donor breastmilk was the top-up measure of choice for ELBW and VLBW infants. Significantly more doctors than dietitians indicated that donor breastmilk is used as a top-up measure. Formula was used for LBW infants, especially in government facilities, possibly because of limited access to donor breastmilk for infants weighing more than 1 500g. Although the difference was not significant, government facilities used powdered formula for LBW infants more readily than RTU formulas, possibly due to their high costs, whereas RTU formulas are used more frequently in private facilities as top-up measures. The results indicate that most healthcare professionals believe that RTU formulas have fewer safety risks than powdered formulas.

The majority of respondents (72.7%) have access to donor breastmilk, either from their own or from an external breastmilk bank. A study published in 2011 illustrated the obstacles concerning the acceptability of donor breastmilk and encouraged awareness, familiarity and education on the use of donor breastmilk. The results of this study indicate that education to improve the acceptability of donor breastmilk among the community and mothers may not yet be sufficient.[50]

The results relating to infant feeding information on discharge indicate that respondents believe that doctors, dietitians and nurses should be involved in providing infant feeding information to caregivers.

Significant differences were observed between doctors and dietitians regarding the recommending supplements on discharge. ESPGHAN recommends iron supplementation for premature infants after discharge for 6–12 months of age[13], which again highlights the importance of an inter-disciplinary and consistent approach among healthcare professionals.

CONCLUSION

Significant differences exist between certain practices between healthcare professionals as well as between hospital sectors. A significant difference was not noted between the total knowledge scores but there was a clinically significant difference between the healthcare professionals with respect to protein prescriptions. Further, larger studies are needed to confirm these findings and the reasons for these differences.

Source of funding

The study was self-funded by the principal researcher.

Conflict of interest

The authors have no conflict of interest to declare.

CHAPTER 4

CONCLUSION AND RECOMMENDATIONS

CHAPTER 4: CONCLUSION & RECOMMENDATIONS

4.1 SUMMARY OF STUDY OBJECTIVES AND DESIGN

The study aimed to determine the knowledge, perceptions and practices of healthcare professionals regarding enteral feeding (including breastfeeding, formula feeding, breastmilk fortifier and donor breastmilk) of premature and LBW infants in South Africa.

The study objectives were:

i. To determine the knowledge of healthcare professionals regarding enteral nutrition in premature and LBW infants in South Africa.
ii. To determine enteral feeding practices for premature and LBW infants.
iii. To determine the perceptions and perceived role of healthcare professionals regarding enteral feeding in premature and LBW infants.
iv. To compare enteral feeding practices relating to premature and LBW infants between government and private hospitals in South Africa.

The null hypotheses directing the study were:

i. There is no difference in the knowledge of healthcare professionals regarding enteral nutrition compared with international recommendations.
ii. There is no difference in the enteral feeding practices of healthcare professionals when compared with international recommendations.
iii. There is no difference between the knowledge, perceptions and practices of healthcare professionals concerning enteral feeding of premature and LBW infants in privately-funded hospitals compared with state-funded hospitals in South Africa.

A descriptive cross-sectional study with an analytical component was conducted from November 2015 until May 2016. The study took the form of an online survey using the web-based program, Survey Monkey. The study population comprised doctors and dietitians from the public and private sectors who are involved in the care and management of premature and LBW infants. A total of 76 participants started the survey, 30 (39%) of whom completed fewer than five survey questions and were

excluded from the data analysis. The final sample was composed of 46 participants. Identified prescribers of enteral feeds for premature and LBW infants were included in the study. For the purpose of this study the “prescriber” was defined as a registered dietitian or doctor (not limited to paediatricians and neonatologists) prescribing feeds for premature and LBW infants on at least a weekly basis.

4.2 ADDRESSING THE STUDY OBJECTIVES

4.2.1 To determine the knowledge of healthcare professionals regarding enteral nutrition in premature and LBW infants in South Africa

The knowledge-based questions included the initiation time and type of enteral feeds, and the typical target energy and protein prescriptions for stable premature infants. These questions were stratified according to weight or gestational age categories. The ESPGHAN and AAP guidelines were considered to be the gold standard and the correct answer.[13,14] No significant difference was found in the knowledge scores between healthcare professionals and among the hospital sectors.

AAP recommends the early initiation of enteral feeds for premature infants and breastmilk is the recommended feed by AAP and ESPGHAN.[13,14] The results of the study indicated that ELBW, VLBW or LBW infants were more likely to be started on enteral feeds within the first 24 hours of life by doctors and by dietitians. These results are similar to a South African study done in 2011 that surveyed paediatricians’ enteral feeding practices of preterm infants.[32] Human milk, the gold standard, was the enteral feed of choice for the majority of doctors and dietitians for all birth weight categories.[13,14,38]

The energy requirements for premature infants can be determined by considering the energy required for metabolic processes, losses and growth. Once these are taken into account, 105–130 kcal/kg/day is required.[6,33,13,14] In some cases, such as in bronchopulmonary dysplasia and ELBW, up to 150 kcal/kg/day may be required.[6] The results of the study indicated that most doctors and dietitians chose an enteral target energy of 100–135 kcal/kg/day for all birth weight categories. One respondent indicated that the presence of bronchopulmonary disease (BPD) needs to be taken into consideration when prescribing energy for premature and LBW infants. The

results of the investigation reveal that healthcare professionals tend to prescribe less protein for all birth weight categories than the requirements recommended by AAP and ESPGHAN.[13,14] A significant difference was found between professions and the daily protein prescriptions of ELBW and LBW infants, with dietitians tending to prescribe more protein across all birth weight categories. Adequate protein intake is essential for adequate postnatal growth and cognitive development.[13,14,33]

4.2.2 To determine enteral feeding practices for premature and LBW infants

The majority of doctors and dietitians attempt to increase enteral feed volume on a daily basis for all birth weight categories. The most common reason for delaying enteral feeds is significant perinatal asphyxia. An earlier study by Raban indicated that the most common reason for not initiating and advancing enteral feeds was the risk of NEC.[32] A significant difference was seen between doctors and dietitians with regard to the full enteral feeding volume. Most doctors considered 161–180 ml/kg/day to be the full enteral feeding volume while more dietitians considered it to be 181–200 ml/kg/day. A full enteral feeding volume of 160–180 ml/kg/day is usually adequate to meet nutritional requirements if preterm formula or fortified human milk is given.[13,72] If unfortified human milk or standard formula is given, larger volumes will be needed to meet nutritional requirements. ESPGHAN recommends 135 ml/kg/day as the minimum and 200 ml/kg/day as the maximum fluid volume, and feeding rates of 150–180 ml/kg/day.[13]

Only half the respondents who completed the questionnaire responded as to whether nutrients are calculated in their facility. The results indicate that more dietitians than doctors are inclined to calculate the nutrient requirements in their facilities and that when nutrient requirements are calculated, energy and protein are also calculated. Significantly more dietitians calculate protein requirements in comparison to doctors.

The results show that the mother's feeding choice was considered by the majority of healthcare professionals. The results also indicate that most clinicians take the infant's exposure to HIV into account when deciding on the type of enteral feed initiated. For HIV-exposed infants, breastmilk is recommended more frequently by healthcare professionals in government facilities than in private facilities. A limitation to this question is addressed in section 4.3.

The nutritional value of breastmilk alone is not sufficient to meet the high growth demands of the premature infant, and human milk needs to be fortified.[14,38,55] The results of the study suggest that most healthcare professionals use human milk fortifier and that it is started at either half strength or full strength.

The majority of facilities had access to donor breastmilk from either an onsite or external breastmilk bank. The most common criterion for prescribing donor milk was insufficient production of the mother's own milk, and if mothers own milk is not available, donor breastmilk should be used. [37]

The results of the study show that mixed feeding does not occur routinely in the facilities. Most respondents used a form of top-up measure when the mother's own milk was not sufficient. Donor milk was the most commonly used top-up measure, especially for ELBW and VLBW infants. Government facilities used donor milk more often than the private sector. Significantly more doctors than dietitians indicated that donor milk was used as a top-up measure for ELBW infants.

The researcher was encouraged that the results indicate that doctors, dietitians and nurses are involved in providing information on infant feeding before discharge. A significant difference was seen between doctors' and dietitians' responses. More doctors than dietitians indicated that all three healthcare professionals are involved in providing infant feeding education. An interdisciplinary team approach is important in the management of premature infants.[65,67]

A significant difference was noted between the doctors' and dietitians' responses for micronutrient supplementation on discharge.

4.2.3 To determine the perceptions and the perceived role of healthcare professionals regarding enteral feeding in premature and LBW infants

Perceptions and beliefs may influence the practices of healthcare professionals. Evaluating the perceptions and beliefs and identifying any misconceptions or gaps in knowledge practices could be improved. The results of the study indicate that the perceptions influenced the practices and no gaps in knowledge or misconceptions were demonstrated. The majority of participants perceive that the optimal choice of

enteral nutrition in the neonatal unit is human milk (mother's own/donor milk). The largest proportion of respondents agreed with the statement that infant formula is safe to use in the neonatal unit and most clinicians felt that powdered infant formula had more safety risks than RTU formula. Most respondents felt that neurological outcomes are negatively affected if specific nutrient requirements are not met, and that it is necessary to calculate specific nutrients for premature infants. Doctors, nurses and dietitians should be responsible for providing information to the mother for making an informed choice regarding feeding choices.

Almost all the healthcare professionals consider donor milk to be acceptable but many believe that mothers do not consider donor milk to be acceptable. The results of the study indicate that most clinicians feel that breastmilk had a positive outcome on the life-saving potential of the premature infant. Human milk fortifier is deemed essential in the management of premature infants who are fed human milk. The largest proportion of respondents feel that mixed feeding increases morbidity and mortality.

4.2.4 To compare enteral feeding practices relating to premature and LBW infants between government and private hospitals in South Africa

Significant differences were found in the following practices between government and private funded hospitals:

i. The initiation time of enteral feeds for VLBW infants varies and feeds are more commonly initiated earlier in the government sector.
ii. The most common reason for delaying enteral feeds was significant perinatal asphyxia. Respondents from the government sector were more likely than those from the private sector to delay feeds for this reason.
iii. A significant difference was found in the energy prescriptions between the government and private sector for each birth weight, but the majority of respondents selected requirements within the recommendations.
iv. Healthcare professionals from the state sector are more likely to advise HIV-positive mothers to breastfeed. A limitation to this question is discussed in section 4.3.

4.2.5 The null hypothesis

$H_{o:}$ There is no difference in the knowledge of healthcare professionals regarding enteral nutrition compared to international recommendations.

The results of the study indicate that there is not a significant difference between the knowledge scores of healthcare professionals regarding enteral nutrition of premature infants when compared with AAP and ESPGHAN recommendations. A significant difference was seen between the energy and protein prescriptions of healthcare professionals. The energy prescriptions are not clinically significant as they fall within the required recommendations, while the protein prescriptions are clinically significant. Therefore, the null hypothesis is accepted based on the overall knowledge scores.

$H_{o:}$ There is no difference in the enteral feeding practices of healthcare professionals compared to international recommendations.

The results of the study indicate that significant differences were found between some of the practices and the professions however these differences were not significant when compared to the international recommendations. Table 4 summarizes the practices in comparison to the international recommendations. The null hypothesis is therefore accepted.

Table 4.1: Comparison of enteral feeding practices and International recommendations

Question that evaluated the practices	Recommendation	Findings
Under which situation would you delay the initiation of enteral feeding?	No recommendation from ESPGHAN and AAP.	The most common reason for delaying enteral feeds was significant perinatal asphyxia (*n* =34, 73.9%).
Minimal enteral (trophic feeding) is defined as feeding with small volumes: - We use minimal enteral feeding for less than 4 days - We use minimal enteral feeding for more than 4 days - We attempt to increase the volume daily	No recommendations from ESPGHAN and AAP. In a study published by Ziegler there is no consensus as to whether feeds should be kept at trophic levels for a certain number of days or whether they should be advanced daily. [27]	Most doctors and dietitians attempt to increase the enteral feed volume on a daily basis for all birth weight categories.
When initiating enteral feeds is the mothers feeding choice taken into account?	No recommendations from ESPGHAN and AAP.	The mother's infant feeding choice was considered by the majority of healthcare professionals working in both government ($n = 29$, 85.3%) and private ($n = 9$, 75%) facilities.
Is the infant's exposure to HIV a consideration when deciding on the type of enteral feed to initiate?	No recommendation from ESPGHAN. The AAP recommends that in the industrialized world HIV-positive mothers do not breastfeed while in the developing world where mortality is increased in non-breastfeeding infants due to malnutrition and infectious diseases breastfeeding may outweigh the risk of acquiring HIV infection.[37] The South African National Consolidated Guidelines for The Prevention of Mother-To-Child-Transmission of HIV (PMCT) and the Management of HIV in Children, Adolescents and Adults states that all HIV-positive, HIV-negative and women with and unknown HIV status should receive at least four antenatal counselling sessions and should be advised to breastfeed during the first six months of life with appropriate complementary foods being introduced at six months. HIV-negative women may continue to breastfeed until 2 years and HIV-positive women may continue to breastfeed until 12 months. Mothers must be counselled on the risks of mixed feeding as	Forty-one (89%) of the respondents indicated that the infant's exposure to HIV was considered when deciding on the type of enteral feed initiated.
If yes, are the mothers of HIV exposed infants advised to feed: - Breast milk - Infant formula - Make an informed decision - Other (specify)		Twenty-one (45.7%) respondents recommended breastmilk if the infant was HIV-exposed. One (2.2%) respondent recommended infant formula and 21 (45.7%) advised mothers to make an informed decision. Two of the respondents who advised mothers to breastfeed recommended pasteurised breast milk, while one respondent recommended donor breastmilk.

	exclusive breastfeeding reduces the risk of HIV transmission. Infants of HIV-positive mothers on second or third-line ART for more than 3 months and have a viral load of more than 1000 copies should not be breastfed. Mothers should be counselled on the importance of lifelong ART adherence and adherence support should be provided. All HIV exposed infants should be provided with NVP alone or with AZT. HIV-positive mothers who decide not to breastfeed after education and counselling must be made aware that infant formula is not provided in public health facilities. [63] The 2016 WHO guidelines on HIV and infant feeding indicate that if a mother who is living with HIV is receiving ARVs and her adherence to ARVs is fully supported, and if she is not virally suppressed, she may continue to breastfeed for up to 24 months.[45]	
What is a typical or full enteral feeding volume for premature and / LBW infants? - < 135ml/kg/day - 140-160ml/kg/day - 161-180ml/kg/day - 181-200ml/kg/day - >200ml/kg/day - Other (specify)	ESPGHAN recommends 150-180ml/kg/day when standard formula or fortified human milk is used. 135ml/kg/day is regarded as the minimum fluid intake and 200ml/kg/day as the maximum fluid intake.[13]	Most healthcare professionals (n=33, 72%) selected an enteral feeding volume of between 140-180ml/kg/day which is within the international recommendations.
Are specific nutrients calculated in your facility?	ESPGHAN as well as AAP provide recommendations for micronutrients as well as macronutrients. [13,14]	The majority of healthcare professionals (58%) did indicate that specific nutrients are calculated in their facilities. Calculating nutrient requirements can help to ensure that international recommendations are met
If yes, who is responsible for calculating the nutrients?	No recommendations from ESPGHAN and AAP.	Twenty-eight (60.9%) respondents answered the question. Four doctors (33.3%) and thirteen dietitians (81.3%) indicated that they were responsible for calculating the nutrient requirements themselves. Five doctors (41.7%) indicated that the dietitians are responsible for calculating the nutrient requirements for premature and LBW infants in their facilities. In summary, the results reveal that more dietitians than

		doctors are inclined to calculate the nutrient requirements in their facilities.
Please select the nutrients that are calculated. - Energy - Protein - Carbohydrates - Fat - Unsure - Other (specify)	ESPGHAN as well as AAP provide recommendations for micronutrients as well as macronutrients. [13,14]	Most the respondents indicated that daily energy and protein levels are calculated [$n = 26$ (93%) and $n = 25$ (89%) respectively]. Significantly more dietitians ($n = 16$, 76.2%) calculate the protein requirements than doctors ($n = 9$, 36%; $p = 0.05$). Approximately half of the respondents indicated that the daily carbohydrate and fat requirements are calculated at their facilities [$n = 15$ (54%) and $n = 16$ (57%) respectively]. Six respondents (21%) include other nutrients such as micronutrients, trace elements and electrolytes.
What criteria is used to prescribe donor milk? - Weight - HIV exposure - Insufficient amount of mothers own milk - Multiple births - Maternal illness - Infant orphaned - Other (please specify)	The AAP recommends pasteurized donor human milk for all preterm infants weighing less than 1 500 g when mothers own milk is not available.[37]	The most frequently selected criterion used to prescribe donor milk was insufficient production of mother's own milk ($n = 24$, 92%). Weight was the second most frequent criterion ($n = 23$. 88%), Maternal illness was the third most commonly chosen criterion for prescribing donor milk ($n = 22$, 84.6%). HIV exposure and multiple births ($n = 15$, 57.7%) were the fourth most frequently selected criteria for prescribing donor milk. The criterion of an orphaned infant was selected by 13 respondents (50%). Four (15.4%) healthcare professionals selected the option "other" and of these, three (75%) indicated that gestational age was used as a criterion for prescribing donor milk, while one (25%) respondent indicated that donor milk is only used for LBW infants.
Is human milk fortifier used in your facility.	ESPGHAN and AAP recommend the use of fortified human milk for preterm infants. [13,14,37]	Forty-two (95%) of the 44 respondents who answered the survey question indicated that they used human milk fortifier in their facilities.
Please indicate the most appropriate answer when initiating human milk fortifier. 1 scoop is equivalent to 1 g of human milk fortifier. - We start with full strength fortifier (1 scoop in 20ml) - We start with half strength fortifier (1/2 scoop in 20ml)	No recommendations from ESPGHAN and AAP.	Twenty-one (50%) respondents initiated human milk fortifier at full strength (1 scoop in 20 ml), 15 (35.7%) at half strength (½ scoop in 20 ml), and three (7.1%) started with quarter strength (¼ scoop in 20 ml), while two (4.8%) were unsure of the initiation strength of human milk fortifier. Two (4.8%) respondents specified their answers: one indicated that the lower the

- We start with quarter strength fortifier (1/4 scoop in 20ml) - Unsure - Other (please specify)		gestational age of the infant, the lower the initiation strength of the human milk fortifier; the other specified that they initiated human milk fortifier in 30–35 ml of human milk per feed.
Does mixed feeding routinely occur in your facility?	No recommendations from ESPGHAN and AAP. The 2016 WHO guiding practice statements on HIV and infant feeding indicate that practising mixed feeding should not be a reason for a mother to stop breastfeeding if ARVs are being used, and that ART use reduces the risk of postnatal HIV transmission in the context of mixed feeding.[45] The South African National Consolidated Guidelines for The Prevention of Mother-To-Child-Transmission of HIV (PMCT) And The Management Of HIV In Children, Adolescents And Adults states that mothers must be counselled on the risks of mixed feeding as exclusive breastfeeding reduces the risk of HIV transmission.[63]	Most respondents indicated that mixed feeding does not routinely occur in their facility ($n = 28$, 62.2%), while 15 respondents (33.3%) indicated that mixed feeding does occur routinely in their facility. Two respondents (4.4%) were unsure.
If mothers own milk is not sufficient what is used as a "top up" measure.	ESPGHAN and AAP do not specify recommendations for top up measures however human milk is recommended for preterm infants. AAP recommends human milk for all infants weighing less than 1500 g if mothers milk is not available or contraindicated. [13,14,37]	Most of the respondents ($n = 38$, 82.6%) used a form of top-up measure for ELBW infants when the mother's own milk was not sufficient. Donor milk was the most commonly used top-up measure ($n = 28$, 60.9%). For infants in the VLBW category, the majority of respondents indicated that top-up measures were used ($n = 41$, 89,1%) if the mother's own milk was not sufficient. Donor milk was used most frequently as a top-up measure in both government ($n = 20$, 58.8%) and private ($n = 6$, 50%) facilities. Top-up measures were also used by most respondents ($n = 41$, 89.1%) for both of the LBW categories. Powdered preterm formula was used more often ($n = 16$, 34.8%) for infants weighing less than 2 000 g compared with other products. Donor milk was the second most commonly used top-up measure for

		infants weighing less than 2 000 g ($n = 13$, 28.3%). For infants with a higher birth weight (< 2 500 g) powdered term ($n = 11$, 23.9%) and preterm formulas ($n = 11$, 23.9%) were used the most frequently.
When a premature or LBW infant is discharged, who is involved in providing information on feeding?	ESPGHAN guidelines indicate that the role of healthcare workers, including the paediatrician is to protect, promote and support breastfeeding. Health care workers should be trained on breastfeeding issues and counselling and should encourage practices in line with the International Code of Breastmilk Substitutes.[39] The AAP defines the paediatricians role in breastfeeding as advocating and supporting proper breastfeeding practices. [37]	The greatest proportion of respondents ($n = 16$, 36.4%) indicated that doctors, dietitians and nurses are involved in providing information on infant feeding before discharge. Five respondents (11.4%) specified their answers: one indicated that the dietitian is not routinely involved in the care of premature infants prior to discharge; two indicated that the nurse and the doctor are the only healthcare professionals involved in infant feeding education before discharge; one indicated that the general paediatrician provides education on infant feeding; and one respondent indicated that the nurse and dietitian provide infant feeding information.
Please indicate if and which of the following supplements are routinely recommended when premature/LBW infants are discharged home.	The AAP recommends an individualized approach to providing human milk fortifier post discharge. The AAP and ESPGHAN advise the following: vitamin containing human milk fortifiers can be used to reach the recommended enteral intake of water soluble vitamins in premature infants fed human milk. In formula fed infants the recommendations may be met by using formula designed for premature infants. Premature infants receiving standard formula milk may require supplementation of fat soluble vitamins (A, D and E) and water soluble vitamins until they reach a weight of 3kg. Preterm infant formula will provide adequate amounts of vitamin A and E. Human milk will need to be supplemented with human milk fortifier containing vitamin A and vitamin E. Additional vitamin D may be needed for infants fed formula (term or preterm formula) and for infants receiving fortified human milk. Intramuscular vitamin K should be given at birth. Preterm formula and fortified human milk should provide adequate amounts of vitamin K. All	Most respondents ($n = 34$, 73.9%) recommend iron (not as part of a multivitamin) on discharge. Twenty-five (54.3%) respondents recommend vitamin D (not as part of a multivitamin). Thirty-five (76.1%) respondents recommended a multivitamin. Eight respondents (17.4%) specified that they recommend other supplements including probiotics, folate and a protein or fat supplement.

	preterm infants should receive 2mg/kg/day of iron until 12 months of age. Preterm formula will provide this iron however human milk will need to be fortified or an iron supplement will need to be given. [13,14] There is insufficient available evidence to routinely recommend the use of pre-and probiotics in premature infants.[13]	

H_0: There is no difference in the knowledge, perceptions and practices of healthcare professionals regarding enteral feeding of premature and LBW infants between privately-funded and state-funded hospitals in South Africa.

The results of the study indicate that there is no difference between the knowledge, perceptions and practices of healthcare professionals regarding enteral feeding of premature and LBW infants between privately-funded and state-funded hospitals in South Africa.

4.3 LIMITATIONS

The following limitations may have influenced the study:

i. The calculated sample size was 74 and a total of 76 survey responses were received. However, only 46 surveys could be used as many of the respondents left out more than five questions. Therefore, the smaller sample size may skew the study results. The hospitals' names and provinces where they were located were not used in the final statistical analysis as the sample size was not big enough to determine cluster effects.
ii. The majority of the respondents (73.9%) were from the government sector while only 29.2% were from the private sector. An over-representation of certain provinces was also found as none of the respondents were from the Freestate or Limpopo while 41.3% were from Gauteng and 21.7% were from the Western Cape.
iii. The questionnaire asked about the hospital level, but this was not clearly defined for the participants in the questionnaire. Variations exist between provinces as well as government and private facilities when classifying the hospital level. The hospital level was, therefore, not used in the statistical analysis.
iv. The questions addressing the practices did not all have defined international recommendations or requirements.
v. One of the questions inquired about the feeding choices of HIV-positive mothers. The question was not specific enough and should have included factors such as the use of ART, the mother's viral load and compliance to ART treatment.

vi. The questions regarding the initiation, time and cessation of human milk fortifier were not specific enough and caused a variety of very different answers which could not be used for statistical analysis.

4.4 RECOMMENDATIONS

Recommendations to address the research question:

i. A larger sample of healthcare professionals would have provided more accurate data and given more weight to proving the significant differences that were found. A larger sample would have helped to determine cluster effects which may result in a form of bias from the different regions and to evaluate levels of hospital (e.g. tertiary, district or regional).
ii. Nursing staff work closely with premature infants and could contribute valuable information if included in the study.
iii. Shortening the questionnaire may assist in retaining and attracting a larger response.

Recommendations for further research

i. Multicentre studies investigating the actual nutrient intakes and prescriptions of enteral and parenteral nutrition prescribers for premature and LBW infants.
ii. Prospective studies evaluating nutrient intakes, enteral feed choice and long-term outcomes such as growth and cognitive development.
iii. Combined enteral and parenteral nutrition surveys, as these forms of nutrition are closely linked, especially in ELBW and VLBW infants before full enteral feeds are tolerated. Due to cost constraints in government-funded facilities, particularly in facilities that are not tertiary or academic, parenteral nutrition may not be used as often as required, which may be valuable information for identifying accrued nutrient deficits.
iv. Investigating the development of human milk fortifier with a higher protein content.
v. Evaluating if perceptions regarding donor breastmilk have changed amongst mothers and communities.
vi. Evaluating the most feasible type of fortification for South Africa.
vii. Evaluating if targeted fortification is feasible in research-limited settings.

REFERENCES

1. World Health Organization. Born Too Soon: The Global Action Report on Preterm Birth. 2012. Available from: http://www.who.int/pmnch/media/news/2012/201204_borntoosoon-report.pdf (Last accessed: November 2016)
2. Blencowe H, Cousens S, Chou D, Oestergaard M, Say L, Moller A, et al. Born too soon: The global epidemiology of 15 million preterm births. Reprod Health. 2013;10 suppl 1. S2.
3. Goldenberg RL, Culhane JF, Iams JD, Romero R, Slattery M, Morrison J, et al. Epidemiology and causes of preterm birth. Lancet. 2008;371(9606):75–84.
4. Beck S, Wojdyla D, Say L, Betran AP, Merialdi M, Requejo JH, et al. The worldwide incidence of preterm birth: A systematic review of maternal mortality and morbidity. Bull World Health Organ. 2010;88(1):31–8.
5. Marlow N. Full term; an artificial concept. Arch Dis Child Fetal Neonatal Ed. 2012;97(3):158–9.
6. Anderson DM. Medical nutrition therapy for Low-Birth-Weight Infants. In: Krauses Food and Nutrition Therapy. 12th ed. Saunders Elsevier; 2008: 1117–40.
7. Fenton TR. A new growth chart for preterm babies: Babson and Benda's chart updated with recent data and a new format. BMC Pediatr. 2003;3(13):1–10.
8. Akram D, Arif F. Ponderal index of low birth weight babies- a hospital-based stud. J Pak Med Assoc. 2005;55:229–31.
9. Rollins NC, Coovadia HM, Bland RM, Coutsidis A, Bennish M, Patel D, et al. Pregnancy outcomes in HIV-infected and uninfected women in rural and urban South Africa. J Acquir Immune Defic Syndr. 2007;44(3):321–8.
10. Short CE., Taylor G. Antiretroviral therapy and preterm birth in HIV-infected women. Expert Rev Anti Infect Ther. 2014;12(3):293–306.
11. Suy A, Matinez E, Coll O, Lonca M, Palacio M, de Lazzari E, et al. Increased risk of pre-eclampsia and fetal death in HIV-infected pregnant women receiving highly active antiretroviral therapy. Aids. 2006;20:59–66.
12. Department of Health: The 2013 National Antenatal Sentinel HIV Prevalence Survey South Africa. Pretoria; 2013. Available from: http://www.health.gov.za/index.php/2014-03-17-09-09-38/reports/category/176-reports-2015 (last accessed: October 2016)
13. Agostoni C, Buonocore G, Carnielli VP, De Curtis M, Darmaun D, Decsi T, et al. Enteral nutrient supply for preterm infants: commentary from the European Society of Paediatric Gastroenterology, Hepatology and Nutrition Committee on Nutrition. J Pediatr Gastroenterol Nutr. 2010;50(1):85–91.
14. American Academy of Pediatrics Commitee on Nutrition. Nutritional needs of the premature infants. In: Pediatric Nutrition 7th ed. 2014: 83–111.
15. Widdowson EM, Mccance RA. The Effect of Finite Periods of Undernutrition at Different Ages on the Composition and Subsequent Development of the Rat. Biol Sci. 1963;158(972):329–42.

16. Ehrenkranz RA, Dusick AM, Vohr BR, Wright LL, Wrage LA, Kenneth Poole W. Growth in the Neonatal Intensive Care Unit Influences Neurodevelopmental and Growth Outcomes of Extremely Low Birth Weight Infants for the National Institutes of Child Health and Human Development Neonatal Research Network. Pediatrics. 2006;117(4):1253–61.

17. Hans DM, Pylipow M, Long JD, Thureen PJ, Georgieff MK. Nutritional Practices in the Neonatal Intensive Care Unit: Analysis of a 2006 Neonatal Nutrition Survey What's Known on This Subject. Pediatrics. 2009;123(1):51–7.

18. Lapillonne A, Griffin IJ. Feeding Preterm Infants Today for Later Metabolic and Cardiovascular Outcomes. J Pediatr. 2013;162:S7-16.

19. Wiedmeier JE, Joss-Moore LA, Lane RH, Neu J. Early postnatal nutrition and programming of the preterm neonate. Nutr Rev. 2011;69(2):76–82.

20. Tudehope D, Vento M, Bhutta Z, Pachi P. Nutritional requirements and feeding recommendations for small for gestational age infants. J Pediatr. 2013;162. Suppl 3.S81–9.

21. Clark RH, Wagner CL, Merritt RJ, Bloom BT, Neu J, Young TE, et al. Nutrition in the neonatal intensive care unit: how do we reduce the incidence of extrauterine growth restriction? J Perinatol. 2003;23(4):337–44.

22. Clark RH, Thomas P, Peabody J. Extrauterine growth restriction remains a serious problem in prematurely born neonates. Pediatrics. 2003;11:986–90.

23. Lunde D. Extrauterine Growth Restriction: What is the Evidence for Better Nutritional Practices in the Neonatal Intensive Care Unit? Newborn Infant Nurs Rev. 2014;14(3):92–8.

24. Ofek Shlomai N, Reichman B, Lerner-Geva L, Boyko V, Bar-Oz B. Population-based study shows improved postnatal growth in preterm very-low-birthweight infants between 1995 and 2010. Acta Paediatr. 2014;103(5):498–503.

25. Evans R, Thureen P. Early feeding strategies in preterm and critically ill neonates. Neonatal Netw. 2001;20(7):7–18.

26. Arslanoglu S, Ziegler EE, Moro GE. Donor human milk in preterm infant feeding: evidence and recommendations*. J Perinat Med. 2010;38:347–51.

27. Ziegler E. Low protein intake from human milk fortified in a routine fashion is the main cause of postnatal growth restriction. Ann Nutr Metab. 2011;58. Suppl 1: 8–18.

28. Morgan J, Bombell S, McGuire W. Early trophic feeding versus enteral fasting for very preterm or very low birth weight infants. Cochrane database Syst Rev. 2013;3(3):CD000504.

29. Hamilton E, Massey C, Ross J, Taylor S. Early enteral feeding in very low birth weight infants. Early Hum Dev. 2014;90(5):227–30.

30. Leaf A, Dorling J, Kempley S, McCormick K, Mannix P, Linsell L, et al. Early or delayed enteral feeding for preterm growth-restricted infants: a randomized trial. Pediatrics. 2012;129(5):e1260-8.

31. Konnikova Y, Zaman MM, Makda M, D'Onofrio D, Freedman SD, Martin CR. Late enteral feedings are associated with intestinal inflammation and adverse neonatal outcomes. PLoS One. 2015;10(7):1–14.

32. Raban MS, Joolay Y, Horn AR HM. Enteral feeding practices in Preterm infants in South Africa. South African J Child Heal. 2013;7(1):8–12.

33. Ziegler EE. Protein Requirements of Very Low Birth Weight Infants. J Pediatr Gastroenterol Nutr. 2007;45. Suppl 3:170–4.

34. Lapillonne A, O'Connor DL, Wang D, Rigo J. Nutritional recommendations for the late-preterm infant and the preterm infant after hospital discharge. J Pediatr. 2013;162. Suppl 3: S90–100.

35. Fallon EM, Nehra D, Potemkin AK, Gura KM, Simpser E, Compher C, et al. A.S.P.E.N. Clinical Guidelines: Nutrition Support of Neonatal Patients at Risk for Necrotizing Enterocolitis. J Parenter Enter Nutr. 2012;36:506–23.

36. Deshpande G, Rao S, Patole S, Ng S, Stoll B, Rowe M, et al. Probiotics for prevention of necrotising enterocolitis in preterm neonates with very low birthweight: a systematic review of randomised controlled trials. Lancet. 2007. 369(9573):1614–1620.

37. American Academy of Pediatrics Commitee on Nutrition. Breastfeeding and the Use of Human Milk. Pediatrics. 2012;129:e827–41.

38. Tudehope DI. Human Milk and the Nutritional Needs of Preterm Infants. J Pediatr. 2013;162:S117-25.

39. Agostoni C, Braegger C, Decsi T, Kolacek S, Koletzko B, Michaelsen KF, et al. Breast-feeding: A commentary by the ESPGHAN Committee on Nutrition. J Pediatr Gastroenterol Nutr. 2009;49(1):112–25.

40. Bauer J, Gerss J. Longitudinal analysis of macronutrients and minerals in human milk produced by mothers of preterm infants. Clin Nutr. 2011;30(2):215–20.

41. Sullivan S, Schanler RJ, Kim JH, Patel AL, Trawö R, Kiechl-Kohlendorfer U, et al. An Exclusively Human Milk-Based Diet Is Associated with a Lower Rate of Necrotizing Enterocolitis than a Diet of Human Milk and Bovine Milk-Based Products. J Pediatr. 2010;156:562–7.

42. Okamoto T, Shirai M, Kokubo M, Takahashi S, Kajino M, Takase M, et al. Human milk reduces the risk of retinal detachment in extremely low-birthweight infants. Pediatr Int. 2007;49(6):894–7.

43. Anderson JW, Johnstone BM, Remley DT. Breast-feeding and cognitive development: A meta-analysis. Am J Clin Nutr. 1999;70(4):525–35.

44. Spiegler J, Preuß M, Gebauer C, Bendiks M, Herting E, Göpel W, et al. Does Breastmilk Influence the Development of Bronchopulmonary Dysplasia? J Pediatr. 2016;169:76–80e4.

45. World Health Organization. Guideline: updates on HIV and infant feeding: duration of breastfeeding, and support from health services to improve feeding practices among mothers living with HIV. 2016.

46. Agostoni C, Axelsson I, Goulet O, Koletzko B, Michaelsen KF, Puntis JWL, et al. Preparation and Handling of Powdered Infant Formula : A Commentary by the ESPGHAN Committee on Nutrition. J Pediatr Gastroenterol Nutr. 2004;39:320–2.

47. Osaili T, Forsythe S. Desiccation resistance and persistence of Cronobacter

species in infant formula. Int J Food Microbiol. 2009;136(2):214–20.

48. Drudy D, Mullane NR, Quinn T, Wall PG, Fanning S. Enterobacter sakazakii : An Emerging Pathogen in Powdered Infant Formula. 2006;42:31–3.

49. Ramani M, Ambalavanan N. Feeding Practices and Necrotizing Enterocolitis. Clin Perinatol. 2013;40(1):1–10.

50. Coutsoudis I, Petrites A, Coutsoudis A. Acceptability of donated breast milk in a resource limited South African setting. Int Breastfeed J. 2011;6(1):3.

51. Coutsoudis I, Adhikari M, Nair N, Coutsoudis A. Feasibility and safety of setting up a donor breastmilk bank in a neonatal prem unit in a resource limited setting: An observational, longitudinal cohort study. BMC Public Health. 2011;11(1):356.

52. South Afican Breast Milk Reserve. Available from: http://www.sabr.org.za/about.html (last accessed November 2016)

53. iThembaLethu. Available from: http://www.ithembalethu.org.za/breastmilk-bank/(last accessed November 2016)

54. Milk Matters. Available from: http://milkmatters.org/(last accessed November 2016)

55. Arslanoglu S, Moro GE, Ziegler EE. Optimization of human milk fortification for preterm infants: New concepts and recommendations. J Perinat Med. 2010;38(3):233–8.

56. Jve B, Nd E, Je H, Mcguire W. Multi-nutrient fortification of human milk for preterm infants (Review). Cochrane Database Syst Rev. 2016;(5):1–44.

57. Tudehope D, Fewtrell M, Kashyap S, Udaeta E. Nutritional Needs of the Micropreterm Infant Developmental Physiology and Biology. J Pediatr. 2013;162:S72-80.

58. Di Natale C, Coclite E, Di Ventura L, Di Fabio S. Fortification of maternal milk for preterm infants. J Matern Neonatal Med. 2011;24(S1):41–3.

59. Kemp JE, Wenhold FAM. Human milk fortification strategies for improved in-hospital growth of preterm infants Human milk fortification strategies for improved in-hospital growth of preterm infants. South African J Clin Nutr. 2016;658:1–8.

60. Coutsoudis A. Breast-feeding and HIV transmission Breast-feeding: HIV infection: Infant nutrition. Nutr Res Rev. 2001;14:191–206.

61. Becquet R, Ekouevi DK, Menan H, Amani-Bosse C, Bequet L, Viho I, et al. Early mixed feeding and breastfeeding beyond 6 months increase the risk of postnatal HIV transmission: ANRS 1201/1202 Ditrame Plus, Abidjan, Côte d'Ivoire. Prev Med. 2008;47:27–33.

62. Rossouw ME, Cornell M, Cotton MF, Esser MM, Rossouw M. Feeding practices and nutritional status of HIV-exposed and HIV-unexposed infants in the Western Cape. South Afr J HIV Med. 2016;17(1):1–10.

63. National consolidated guidelines for the prevention of mother-to-child transmission of HIV (PMTCT) and the management of HIV in children, adolecsents and adults. National Department of Health. Available from:

Available from: http://www.sahivsoc.org/practise-guidelines/national-dept-of-health-guidelines (last accessed February 2017)

64. World Health Organization. Kangaroo mother care: A practical guide. WHO Reprod Heal Res [Internet]. 2003;73(5):1–54. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22585327

65. World Health Organization. WHO Recommendations on Interventions to Improve Preterm Birth Outcomes. 2015;98.

66. Conde-Agudelo A, Díaz-Rossello JL. Kangaroo mother care to reduce morbidity and mortality in low birthweight infants. Cochrane Database of Systematic Reviews. 2014;(4):4–6.

67. Feucht U, van Rooyen E, Skhosana R, Bergh AM. Taking kangaroo mother care forward in South Africa: The role of district clinical specialist teams. South African Med J. 2016;106(1):49–52.

68. World Health Organization and UNICEF. Baby Friendly Hospital Initiative. 2009 [cited 2017 Jan 1]. Available from: http://www.who.int/nutrition/publications/infantfeeding/bfhi_trainingcourse/en/ (last accessed February 2017)

69. Patole SK, de Klerk N. Impact of standardised feeding regimens on incidence of neonatal necrotising enterocolitis: a systematic review and meta-analysis of observational studies. Arch Dis Child Fetal Neonatal Ed. 2005;90(2):F147-51.

70. Gephart SM, Hanson CK. Preventing Necrotizing Enterocolitis With Standardized Feeding Protocols. Adv Neonatal Care. 2013;13(1):48–54.

71. McGuire W, Young L, Morgan J. Preventing necrotising enterocolitis in very preterm infants: Current evidence. Paediatr Child Health. 2015;25(6):265–70.

72. Klingenberg C, Embleton ND, Jacobs SE, O'Connell L a. F, Kuschel C a. Enteral feeding practices in very preterm infants: an international survey. Arch Dis Child - Fetal Neonatal Ed. 2012;97(1):F56–61.

73. Patole S, Muller R. Enteral feeding of preterm neonates: a survey of Australian neonatologists. J Matern Neonatal Med. 2004 Nov 1;16(5):309–14.

74. Ziegler EE, Thureen PJ, Carlson SJ. Aggressive nutrition of the very low birthweight infant. Clin Perinatol. 29(2).

75. Ziegler EE, Carlson SJ. Early nutrition of very low birth weight infants. J Matern Fetal Neonatal Med. 2009;22(3):191–7.

APPENDICES

Appendix A: ADVERTISEMENT

RESEARCH PROJECT

INSTITUTION: University of Stellenbosch

TYPE OF PROJECT: An online questionnaire investigating the knowledge, perceptions and practices of healthcare professionals regarding enteral feeding of premature and low birth weight infants in South Africa.

CONTACT PERSON: Margot Bradfield 073 516 8218

Please click the link below for the participant information and for more information about the survey.

https://www.surveymonkey.com/r/CQQ95G2

After completing the survey there is an option to enter a lucky draw to win a R4 000 sponsorship to a neonatal or paediatric conference.

Appendix B: QUESTIONNAIRE

The knowledge, perceptions and practices of healthcare professionals regarding enteral feeding of premature and low birth weight infants in South Africa

1. Welcome to My Survey

Thank you for participating in our survey. Your feedback is important.

PARTICIPANT INFORMATION LEAFLET

TITLE OF THE RESEARCH PROJECT:
The knowledge, perceptions and practices of healthcare professionals regarding enteral feeding of premature and low birth weight infants in South Africa.

REFERENCE NUMBER: S14/10/253

PRINCIPAL INVESTIGATOR: Margot Bradfield

ADDRESS: Division of Human Nutrition, Faculty of Medicine and Health Sciences, University of Stellenbosch, P.O Box 19063, Francie van Zijl Drive, Tygerberg 7505.

CONTACT NUMBER: 073 516 8218

E-MAIL ADDRESS: bradfieldml@gmail.com

Dear Colleague,

My name is Margot Bradfield and I would like to invite you to participate in a research project that aims to investigate the knowledge, perceptions and practices of healthcare professionals regarding enteral feeding of premature and low birth weight (LBW) infants in South Africa.

Please take some time to read the information presented here, which will explain the details of this project and contact me if you require further explanation or clarification of any aspect of the study. Also, your participation is entirely voluntary and you are free to decline to participate. If you decline, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the Health Research Ethics Committee (HREC) at Stellenbosch University and will be conducted according to accepted and applicable National and International ethical guidelines and principles, including those of the international Declaration of Helsinki October 2013.

What is this research study all about?

The study will be conducted as an online questionnaire. Healthcare professionals, specifically doctors and dietitians, who are involved in the treatment and management of premature and LBW infants from all of the nine provinces in South Africa are invited to participate in the study.
This includes healthcare professionals from the government as well as from the private sector.

The questionnaire will consist of sections which will evaluate knowledge, perceptions and practices

with regards to enteral feeding in premature and low birth weight infants.

Due to the electronic nature of the study all of the questionnaires will be anonymous. A coding system has been devised so that the name of the hospital will remain anonymous and will not be linked to the questionnaire. The principal investigator is the only one aware of the coding system and the method of coding will remain confidential and will be protected in a password protected folder on a password protected computer.

At the end of the questionnaire there will be an option to submit personal details (name, contact number and e-mail address) in order to be entered into a lucky draw and to receive the results of the study.

Why have you been invited to participate?

You have been invited to participate in the study due to your involvement in the treatment and management of premature and LBW infants.

There are approximately 480-500 healthcare professionals that would meet the inclusion criteria and in order to obtain meaningful results and improve the validity and the significance of the study it is necessary to have participation from all of these healthcare professionals.

What will your responsibilities be?

The only responsibilities will be to answer the online questionnaire which will take approximately twenty minutes.

Will you benefit from taking part in this research?

The study will not directly benefit you. The results of the study will be beneficial as more information will be gained and we will be able to identify any major differences, misconceptions or gaps in the current knowledge, perceptions and practices with regards to the enteral feeding of this vulnerable group. Two thousand and fifteen is also the year for review of the progress of the millennium development goals and this survey may provide some valuable information in the treatment and management of these infants. The information can be used to create enteral feeding strategies, protocols and awareness for the improved management of premature and LBW infants.

Are there in risks involved in your taking part in this research?

There are no risks involved for the participant.

Who will have access to the information?

Only the principal investigator will have access to all of the information. Due to the electronic nature of the survey all of the questionnaires will be anonymous. All participants, including the ones who submitted their personal details, and hospitals will remain anonymous to any other individuals involved in the study and the principal investigator will keep this information confidential. It will be protected in a password protected folder on a password protected computer and any hard copies will be kept locked in a cabinet. If the results of the study are published all participants will remain anonymous.

Will you be paid to take part in this study and are there any costs involved?

You will not be paid to participate in the study but there is a lucky draw that can be entered. The lucky draw will consist of a R4 000 sponsorship for a paediatric or neonatal conference. The personal details will not be able to be linked to the answered questionnaire.

Is there anything else that you should know or do?

- You can contact the Principal Investigator Margot Bradfield at tel 073 516 8218 if you have any further queries or encounter any problems.

- You can contact the Health Research Ethics Committee at 021-938 9207 if you have any concerns or complaints that have not been adequately addressed by your study doctor.

- You will receive a copy of this information and consent form for your own records if you require it. The principal investigator, Margot Bradfield, can be e-mailed at bradfieldml@gmail.com and a copy will be sent to you.

By completing the questionnaire you are granting your informed consent and are declaring the following

- I have read the information and consent form and it is written in a language with which am fluent and comfortable.

- I have had a chance to ask questions and all of my questions have been adequately answered.

- I understand that taking part in the study is voluntary and I have not been pressurised to take part.

- I may choose to leave the study at any time and will not be penalised or pressurised in any way.

Yours sincerely,

Margot Bradfield

Principal Investigator

The knowledge, perceptions and practices of healthcare professionals regarding enteral feeding of premature and low birth weight infants in South Africa

2. Background information

1. Please select the province that you are working in

2. Please select the type of hospital where you work the majority of your hours

	Hospital level
Government	
Private	

3. What is the name of the hospital where you work the majority of your working hours?

4. Please select your qualification

- ○ Community Service Medical Officer
- ○ Medical Officer
- ○ Paediatrician
- ○ Neonatologist
- ○ Dietitian
- ○ Community Service Dietitian

Other (please specify)

The knowledge, perceptions and practices of healthcare professionals regarding enteral feeding of premature and low birth weight infants in South Africa

2. Facility background

5. How many neonatal intensive care beds does your facility have?

6. How many neonatal high care beds does your facility have?

7. Does your facility have a Kangaroo Mother Care Unit?

Yes

No

8. Does your facility have a standardised infant feeding protocol?

The knowledge, perceptions and practices of healthcare professionals regarding enteral feeding of premature and low birth weight infants in South Africa

4. Timing and type of enteral feeds

Please answer the questionnaire according to your actual prescriptions, practices and beliefs with regards to the enteral feeding of premature and low birth weight infants.

The following abbreviations and classifications have been used:

- Extremely low birth weight (ELBW) < 1000 g
- Very low birth weight (VLBW) < 1500 g
- Low birth weight (LBW) < 2500 g

9. Based on gestational age when do you initiate enteral feeds in premature and or LBW infants? (excluding major congenital abnormalities)

If weight is used as the criteria please see the suggested categories in brackets

	0 - 24 hours of life	24 - 48 hours of life	48 - 72 hours of life	> 72 hours of life
< 28 weeks (< 1000 g)				
Other (please specify)				
< 31 weeks (< 1500 g)				
Other (please specify)				
< 34 weeks (< 2000 g)				
Other (please specify)				
< 37 weeks (< 2500 g)				
Other (please specify)				

10. Under which situations would you delay the onset of enteral feeding? Please indicate all relevant options.

- [ ] Growth restricted infants
- [ ] Reversed end diastolic flow in umbilical artery
- [ ] Significant perinatal asphyxia
- [ ] Not yet passed meconium
- [ ] Indwelling umbilical arterial catheter
- [ ] Severe hypotension
- [ ] Other (please specify)

11. Minimal enteral (trophic) feeding is defined as feeding with small volumes i.e. 0.5-1 ml/kg/d up to a maximum of 20 ml/kg/d

Please tick the most appropriate answer that applies to your practices when initiating enteral feeds in premature and / or LBW infants.

	We use minimal enteral feeding for less than 4 days	We use minimal enteral feeding for more than 4 days	We attempt to increase the volume on a daily basis if possible
ELBW	◯	◯	◯
VLBW	◯	◯	◯
LBW	◯	◯	◯

Other (please specify)

12. When enteral feeds are initiated what is the usual feed or liquid that is given first in your facility?

	Dextrose water	Human milk (mother's milk / donor milk)	Premature infant formula (reconstituted)	Premature infant formula (ready to use)	Term infant formula (reconstituted)	Term infant formula (ready to use)	Unsure
ELBW	◯	◯	◯	◯	◯	◯	◯
Other (please specify)							
VLBW	◯	◯	◯	◯	◯	◯	◯
Other (please specify)							
LBW	◯	◯	◯	◯	◯	◯	◯
Other (please specify)							

13. When initiating enteral feeds is the mother's feeding choice taken into account?

- ◯ Yes
- ◯ No

14. Is the infant's exposure to Human Immunodeficiency Virus (HIV) a consideration when deciding on the type of enteral feed to initiate?

15. If yes, are the mothers of HIV exposed infants advised to feed:

- ☐ Breast milk
- ☐ Infant formula
- ☐ Make an informed decision
- ☐ Other (please specify)

16. In the neonatal unit what do you believe is the optimal choice of enteral nutrition?

17. What is your opinion on the lifesaving potential of human milk in premature and LBW infants?

18. What is your view on the safety of using infant formula in the neonatal unit?

	I agree with this statement	I do not agree with this statement	Other
Infant formula is safe to use in the neonatal unit	◯	◯	◯
Other (please specify)			
Infant formula is not safe to use in the neonatal unit	◯	◯	◯
Other (please specify)			
My view is neutral	◯	◯	◯
Other (please specify)			

19. What is your opinion on the use of ready to use infant formula compared with powdered infant formula? Please select all appropriate answers.

- [ ] There is no difference between ready to use infant formula and powdered infant formula.
- [ ] There is a difference between ready to use and powdered infant formula.
- [ ] Powdered infant formula has more safety risks compared to ready to use infant formula.
- [ ] Ready to use infant formula has more safety risks compared to powdered infant formula.
- [ ] Powdered infant formula is nutritionally superior to ready to use infant formula.
- [ ] Ready to use infant formula is nutritionally superior to powdered infant formula.
- [ ] Other (please specify)

20. Who do you believe should be responsible to provide information to the mother for making an informed decision with regards to infant feeding choices? Please select all appropriate options.

- [ ] Doctor
- [ ] Dietitian
- [ ] Nurse
- [ ] Other (please specify)

21. Where do you mostly receive information on infant feeding?

22. What is a typical or usual full enteral feeding volume for premature and / LBW infants?

23. Please describe how you feel about the practice of using only fluid volumes to prescribe enteral feeds and not calculating any of the nutrient requirements for premature and LBW infants.

24. What is your view on the safety of using infant formula in the neonatal unit?

	I agree	I disagree	Other
It is safe to use infant formula in the neonatal unit	○	○	○
Other (please specify)			
It is not safe to use infant formula in the neonatal unit	○	○	○
Other (please specify)			
Neutral	○	○	○
Other (please specify)			
Other	○	○	○
Other (please specify)			

The knowledge, perceptions and practices of healthcare professionals regarding enteral feeding of premature and low birth weight infants in South Africa

4. Nutritional requirements

25. What is your opinion on calculating specific nutrients for enteral feeding of premature and LBW infants?

26. Are specific nutrients calculated in your facility?

○ Yes

○ No

○ Unsure

If yes please proceed to question 27.If no or unsure please proceed to question 9.

27. Who is responsible for calculating the nutrients?

28. Please select the nutrients that are calculated. Please select all appropriate answers.

- [ ] Energy
- [ ] Protein
- [ ] Carbohydrates
- [ ] Fat
- [ ] Other (please specify)

For question 29 and 30 please select the answer that you perceive as being the most correct answer.

29. Please indicate the typical "target" for energy for stable premature infants. If you use weight as cut off values, please see the suggested limits in brackets)

	< 100 kcal/kg/d	100 - 135 kcal/kg/d	136 - 150 kcal/kg/d
< 28 weeks (< 1000 g)	○	○	○
Other (please specify)			
< 31 weeks (< 1500 g)	○	○	○
Other (please specify)			
< 34 weeks (< 2000 g)	○	○	○
Other (please specify)			
< 37 weeks (< 2500 g)	○	○	○
Other (please specify)			

30. Please indicate which protein requirements would be the most suitable for the optimal growth of premature infants. If weight is used as cut off criteria, please see the suggested limit in brackets.

	1.5 - 2.5 g/kg/d	2.5 - 3 g/kg/d	3.5 - 4.5 g/kg/d
< 28 weeks (< 1000 g)	○	○	○
Other (please specify)			
< 31 weeks (< 1500 g)	○	○	○
Other (please specify)			
< 34 weeks (< 2000 g)	○	○	○
Other (please specify)			
< 37 weeks (< 2500 g)	○	○	○
Other (please specify)			

31. What is your view on the neurological outcome of premature and LBW infants if specific nutrient requirements are not met? Please select the most appropriate answer.

Other (please specify)

The knowledge, perceptions and practices of healthcare professionals regarding enteral feeding of premature and low birth weight infants in South Africa

6. Donor milk

32. What is your belief on the acceptability of the use of donor milk among healthcare professionals?

- ○ Acceptable
- ○ Not acceptable

Other (please specify)

33. What is your belief on the acceptability of donor milk among mothers?

- ○ Acceptable
- ○ Not acceptable
- ○ Other (please specify)

34. Does your facility have access to donor breastmilk? Please indicate which options apply to your situation.

- [ ] Yes, we have a breastmilk bank
- [ ] Yes, we have access to donor milk from an external breastmilk bank
- [ ] No, we do not have access to donor milk
- [ ] Other (please specify)

If you have answered yes to question 34, please proceed to question 35. If you have answered no to question 35 please continue to the next section, (titled Human Milk Fortifier).

35. What criteria are used to prescribe donor milk? Please select all appropriate options.

- [ ] Weight
- [ ] HIV exposure
- [ ] Insufficient amount of mothers own milk
- [ ] Multiple births
- [ ] Maternal illness
- [ ] Infant orphaned
- [ ] Other (please specify)

The knowledge, perceptions and practices of healthcare professionals regarding enteral feeding of premature and low birth weight infants in South Africa

7. Human milk fortifier

36. Please describe your beliefs on the use of human milk fortifier.

37. Is human milk fortifier used in your facility?

- ○ Yes
- ○ No
- ○ Unsure

If you answered yes to question 37 please proceed to answer question 38 to 41. If you answered no or unsure please proceed to the next section (titled Mixed Feeding).

38. When is human milk fortifier initiated?

Please select all appropriate answers and indicate the specific values.

Postnatal age	
Volume of enteral feeds tolerated	
Other (specify)	

39. When is human milk fortifier stopped?

Please select all appropriate options and indicate the values.

Reached a certain weight (weight in grams)	
Reached a certain corrected or postnatal age (weeks / months)	
Only or full breastfeeding	
At discharge	

40. Please indicate the most appropriate answer when initiating human milk fortifier.

1 scoop is equivalent to 1 g of human milk fortifier.

41. Please specify the number of days the human milk fortifier is used as indicated in question 37.

The knowledge, perceptions and practices of healthcare professionals regarding enteral feeding of premature and low birth weight infants in South Africa

8. Mixed feeding

Mixed feeding for the purpose of this survey can be described as the use of infant formula and breast milk in one infant. The use of human/breast milk fortifier is not considered to be mixed feeding for the purpose of this survey.

42. What is your opinion on mixed feeding influencing morbidity and mortality in premature and LBW infants?

43. Does mixed feeding routinely occur in your facility?

- ◯ Yes
- ◯ No
- ◯ Unsure

44. If the mother's own milk is not sufficient what is used as a "top-up" measure. Please select all appropriate answers, more than one answer can be selected for each category.

	Top-up measures are not used	Donor milk is used if the caregiver / mother consents	Powdered term infant formula	Ready to use term infant formula	Powdered preterm infant formula	Ready to use preterm infant formula	Usure
< 28 weeks (< 1000 g)	☐	☐	☐	☐	☐	☐	☐
< 31 weeks (< 1500 g)	☐	☐	☐	☐	☐	☐	☐
< 34 weeks (< 2000 g)	☐	☐	☐	☐	☐	☐	☐
< 37 weeks (< 2500 g)	☐	☐	☐	☐	☐	☐	☐

Other (please specify)

The knowledge, perceptions and practices of healthcare professionals regarding enteral feeding of premature and low birth weight infants in South Africa

9. Discharge

45. When a premature or LBW infant is discharged home who is involved in providing information on feeding?

46. Please indicate if and which of the following supplements are routinely recommended when premature / LBW infants are discharged home

- ☐ Iron (not part of a multivitamin)
- ☐ Vitamin D (not part of a multivitamin)
- ☐ Human milk fortifier
- ☐ Multivitamins
- ☐ None
- ☐ Other

Other (please specify)

The knowledge, perceptions and practices of healthcare professionals regarding enteral feeding of premature and low birth weight infants in South Africa

10. Thank you

Thank you for your time and input!

In order to enter the lucky draw competition to win a R 4 000 sponsorship to a neonatal or paediatric conference of your choice please submit your name, surname and contact details to bradfieldml@gmail.com. The answered survey will not be linked to the e-mail and the survey will remain anonymous.

Appendix C: SUPPLEMENTARY TABLES

Supplementary table: Perceptions of the enteral feeding choice

Question	Response	%	Dietitian	Doctor	Govern-ment	*n* Private

In the neonatal unit which do you believe is the optimal choice of enteral nutrition (*n* = 46)	- Human milk (mother own/donor)
	- Unsure
	- Other (specify):
	  - Mother own milk more so than donor milk
	  - Not applicable
		43 (93.5%)
		1 (2.2%)
		2 (4.3%)
			19 (19.5%)
			0
			2 (9.5%)
				24 (96%)
				1 (4%)
				0
					32 (94.1%)
					0
					2 (5.9%)
						11 (91.7%)
						1 (8.3%)
						0

What is your view on the safety of using infant formula in the neonatal unit?						

Infant formula is safe to use in the neonatal unit **(*n* = 44)**	- I agree with this statement
	- I do not agree with statement
	- Other (specify):
	  - Less safe than mother's milk but still safe
	  - Can be used safely for specific indications
	  - It depends on age and weight of the patient
	  - Dependent on the clinical situation
	  - If the staff are properly trained to know which formula to start with it is safe
	  - If breast milk is not available, then formula is generally safe if safely prepared
	  - Only if no safe human milk is available
	  - Only when medically indicated and if it is a preterm infant formula which is calculated by a dietitian and correctly used.
	  - If it is mom's choice and it is prepared correctly and baby weighs more than 1.5 kg
	  - Formula should only be considered as last resort. Only ready mix formulas should then be used in neonatal ICU environment
		20 (45.5%)
		14 (31.8%)
		10 (22.7%)
			11 (55%)
			6 (30%)
			3 (15%)
				9 (37.5%)
				8 (33.3%)
				7 (29.2%)
					14 (43.8%)
					12 (37.5)
					6 (18.8%)
						6 (50%)
						2 (16.7%)
						4 (33.3%)

Question	Response	%	Dietitian	Doctor	Govern-ment	*n* Private
Infant formula is not safe to use in the neonatal unit **(*n* = 42)**	- I agree with this statement - I do not agree with statement - Other (specify): - Less safe than mother's milk but still safe - It depends on gestational age and weight of the patient - Dependent on the clinical situation - If breast milk is not available, then formula is generally safe if safely prepared - It is usually not the number one choice of feed - Under circumstances where mom cannot produce milk or mom is in ICU or far way (no mother lodger facilities) - It is sometimes necessary - If it is mom's choice and its prepared correctly and baby weighs more than 1.5kg - Formula should only be considered as last resort. Only ready mix formulas should then be used in neonatal ICU environment	13 (30.9%) 19 (45.2%) 10 (23.8%)	7 (33.3%) 11 (52.4%) 3 (14.3%)	6 (28.6%) 8 (38.1%) 7 (33.3%)	11 (34.4%) 14 (43.8%) 7 (21.9%)	2 (20%) 5 (50%) 3 (30%)
My view is neutral (*n* = 29)	- I agree with the statement - I do not agree with the statement - Other	6 (20.7%) 15 (51.7%) 8 (27.6%)	4 (28.6%) 8 (57.1%) 2 (14.3%)	2 (13.3%) 7 (46.7%) 6 (40%)	5 (20.8%) 14 (58.3%) 5 (20.8%)	1 (20%) 1 (20%) 3 (60%)
What is your opinion on the use of ready-to-use infant formula compared with powdered infant formula? Please select all appropriate answers. (*n* = 46)	- There is no difference between RTU infant formula and powdered infant formula - There is a difference between RTU infant formula and powdered infant formula - Powdered infant formula has more safety risks compared to RTU infant formula - RTU infant formula has more safety risks compared to powdered infant formula - Powdered infant formula is nutritionally superior to RTU infant formula - RTU infant formula is nutritionally superior to	1 (2.2%) 22 (47.8%) 36 (78.3%) 3 (6.5%) 2 (4.3%) 2 (4.3%) 8 (17.4%)	1 (4.8%) 12 (57.1%) 20 (95.2%) 0 1 (4.8%) 2 (9.5%) 2 (9.5%)	0 10 (40%) 16 (64%) 3 (12%) 1 (4%) 0 6 (24%)	1 (2.9%) 17 (50%) 29 (85.3%) 2 (5.9%) 2 (5.9%) 1 (2.9%) 3 (8.8%)	0 4 (41.7%) 7 (58.3%) 1 (8.3%) 0 1 (8.3%) 5 (41.7%)

Question	Response	%	Dietitian	Doctor	Govern-ment	*n* Private
	powdered infant formula - Other (specify): -Risk of contamination with powdered formula - RTU best option for formula feeding - Cost RTU limiting/no access - No experience/not enough knowledge on formula					
What is your view on the neurological outcome of premature and LBW infants if specific nutrient requirements are not met? Please select the most appropriate answer (*n* = 45)	- The neurological outcome will be negatively affected if specific nutrient requirements are not met - The neurological outcome will be positively affected if specific nutrient requirements are not met - I am unsure if the neurological outcome will be affected if specific nutrient requirements are not met - I do not have a view on whether the neurological outcome will be affected if specific nutrient requirements are not met - Other	39 (86.7%) 1 (2.2%) 3 (6.7%) 1(2.2%) 1 (2.2%)	18 (85.7%) 0 2 (9.5%) 1 (4.8%) 1 (4.8%)	21 (87.5%) 1 (4.2%) 1 (4.2%) 0 0	32 (94.1%) 1 (2.9%) 1 (2.9%) 0 0	7 (63.6%) 0 2 (18.2%) 1 (9.1%) 1 (9.1%)
What is your opinion on calculating specific nutrients for enteral feeding of premature and LBW infants? (*n* = 45)	- It is necessary to calculate specific nutrients - It is not necessary to calculate specific nutrients - No opinion - Other (specify)	37 (82.2%) 4 (8.9%) 1 (2.2%) 3 (6.7%)	19 (90.5%) 2 (9.5%) 0 0	18 (75.0%) 2 (8.3%) 1 (4.2%) 3 (27.3%)	30 (88.2%) 3 (8.8%) 1 (2.9%) 0	7 (63.6%) 1 (9.1%) 0 3 (27.3%)

Supplementary table: Infant feeding information

Question	Response	N (%)

Who do you believe should be responsible for providing information to the mother to make an informed decision with regard to infant feeding choices? (*n* = 46)	- Doctor
	- Dietitian
	- Nurse
	- Other
	  - Every health worker coming into contact with the mother
	  - All of the above
	  - All of the above need to give the same message
	  - Lactation nurses, community members
	  - Lactation consultant
	  - I feel it should be done as a team
	  - Everybody starting in ANC clinic already
	  - In the neonatal ICU the attending neonatologist alternatively a paediatric dietitian trained in neonatology and low birth weight infants, general dietitians do more harm than good
		33 (71.7%)
		37 (80.4%)
		33 (71.7%)
		9 (19.6%)

Supplementary table: Beliefs and perceptions on the use of donor breastmilk

Question	Response	*n* (%)
What is your belief on the acceptability of the use of donor milk among healthcare professionals? (*n* = 45)	- Acceptable - Not acceptable	44 (97.8%) 1 (2.2%)
What is your belief on the acceptability of donor milk among mothers? (*n* = 44)	- Acceptable - Not acceptable - Other (specify)	14 (31.8%) 18 (40.9%) 12 (27.3%)

Supplementary table: Qualitative questions

Question	Themes identified	N %
Please describe how you feel about the practice of using only fluid volumes to prescribe enteral feeds and not calculating any of the nutrient requirements for premature and LBW infants. **(*n* = 43)**	- It is fine to use if the infant is growing adequately - It is not accurate and the correct practice - Nutrient requirements should be calculated' nutrient requirement for expressed breast milk - It is safe and practical	2 (4.7%) 13 (30.2%) 19 (44.2%) 5 (11.6%) 1(2.3%) 3 (7.0%)
What is your opinion on the lifesaving potential of human milk in premature and LBW infants? **(*n* = 41)**	- Mother's own milk is optimal and donor milk not as optimal - Breastmilk has life-saving potential - Has life-saving potential but not a viable option	1 (2.4%) 39 (95.1%) 1 (2.4%)
Please describe your beliefs on the use of human milk fortifier. **(*n* = 42)**	- Essential for premature infants - Carbohydrate to protein ratio needs to be calculated - Insufficient studies regarding whether it constitutes as mixed feeding - Not routinely necessary for all infants - Only start once tolerating 60% oral feeds	38 (82.6%) 1 (2.2%) 1 (2.2%) 1 (2.2%) 1 (2.2%)
What is your opinion on mixed feeding influencing morbidity and mortality in premature and LBW infants? **(*n* = 40)**	- Generally, safe - Negative effect - Increases morbidity and mortality - Not sure - Can be problem in uncontrolled/non hygienic environment - Increased risk of HIV transmission in HIV-exposed infants - Neutral - Better than underfeeding - Decreased morbidity and mortality - Not advised - Not always possible to fully breastfed - Unproven	1 (2.2%) 1 (2.2%) 22 (47.8%) 1 (2.2%) 1 (2.2%) 7 (15.2%) 1 (2.2%) 2 (4.3%) 1 (2.2%) 1 (2.2%) 1 (2.2%) 1 (2.2%)